HELSINKI SCHOOL OF ECONOMICS (HSE)
Department of Business Technology

THE ROLE OF THE ENTERPRISE RESOURCE PLANNING SYSTEMS IN SUPPLY CHAIN MANAGEMENT –CASES FROM THE TEXTILE AND CLOTHING INDUSTRY

Information System Science
Master's thesis
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ABSTRACT

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The Role of Enterprise Resource Planning (ERP) Systems in Supply Chain Management- Cases from the Textile and Clothing Industry

Objectives of the Study

The main objective of this thesis was to investigate Enterprise Resource Planning (ERP) applications in the textile and apparel industry. This study is aiming to review the role of the ERP systems in Supply Chain Management in the industry where supply chains have become more complex networks of suppliers and subcontractors. Supply Chain Management is approached through integration and key business processes. The evaluation is done by the help of the framework created in this study

Material and Research Methodology

This thesis includes three different parts: theoretical, industrial and empirical parts. Theoretical part describes ERP systems, concept of Supply Chain Management, its coordination and integration. In the industry review the focus is in describing the information systems used in the textile and clothing industry, supply chain structure and management practises. Finally, the empirical part introduces first four pilot cases that were executed in order to create an evaluation framework together with the theoretical part of this thesis. Using this evaluation framework a detailed and thorough case study was conducted. The supply chain practises were reviewed with the help of key business processes and the integration was studied from three aspects: forms, levels and stages of integration. In all the key business processes the role of ERP was evaluated.

Results

Industry specific ERP systems are very common in the textile and clothing industry. In addition with in-house developed systems Finnish textile and clothing companies seemed to favour best-of-breed approach in their ERP solutions. ERP provided mostly support for internal process and information integration, especially in sales and order management. However, along with EDI connection the integration with retailers has been developing during last years and nowadays demand information is applied efficiently, thanks to effective information systems. In the future companies in the industry are developing their cooperation also with the suppliers and subcontractors.

Key Words

Textile Industry, Clothing Industry, Supply Chain Management, Integration, Enterprise Resource Planning (ERP)

1. Introduction

1.1 Background of the study

In continuously changing business environment, companies must anticipate, be prepared and be able to develop their processes for the future. In order to compete in the global business environment, companies are using information technology to support business process development and therefore are also increasing needs of information. Thus, both large and small- and medium size companies are using nowadays Enterprise Resource Planning (ERP) systems to integrate processes, information and people across different functions. At the same time Supply Chain Management (SCM) has received considerable support as the importance of logistics has become evident. On the other hand different kinds of SCM systems have been develop in order to response this growing need. The overall goal for companies is to improve their operational efficiency and that way to maintain competitive abilities.

Increasing global competition has had big impact to the textile and clothing industry where the companies all over the world have been forced to seek competitive edge from different sources. In addition with the use of information technology (IT), more efficient supply chains are one way to improve the performance. Increasing demand for shorter delivery times, smaller lot sizes as well as higher demands for products and services have increased the needs of information technology in the textile and clothing industry. Concepts like Quick Response (QR), Efficient Consumer Response (ECR) and Just-In-Time (JIT) inventory systems have been developed in order to improve competitiveness and along with these applications also ability respond changing customer demands have required appliance of different kind of IT solutions. Information technology can provide tools for utilize available information, which can be quite crucial for succeeding. Fashion industry's typical characteristics, like short lifecycles, high volatility, low predictability and high impulse purchase set high challenges to logistics and also to information systems supporting it (Christopher *et al.*, 2004).

According to Parnell (1999) while the clothing industry has grown and become more complex, also the challenges for information utilization have grown as well. Parnell argues

that more information is collected than ever before and the gained data is analyzed, shared and used both internally and externally. New information systems have ability to support integrated processes, while these systems support information visibility, integration and growth and provide better abilities to serve customers. Future themes for success will be among the others efficient business processes and visible, accurate and complete information.

Different kinds of publicly sponsored development programs: for example, "Nice Net" (Riikonen and Valkokari, 2004) and Taitava Tevanake –TexIT (Heiskanen, 2004), have been executed in order to provide guidelines and help to the Finnish textile and clothing industry to manage harder competition and develop the competitive resources of companies. In these projects information technology and logistics strategies have been seen ways to improve competitive advantage. Haimakainen *et al.* (2000) suggest as well that use of information technology in the textile and clothing industry should be surveyed in order to improve the strategic conditions of Finnish companies in the sector. The textile and clothing industry is becoming more complex due to the fact that network of suppliers, subcontractors and customers is growing and along with that also needs for applicable information is greater than ever. For these reasons it's really important to study the role of Enterprise Resource Planning (ERP) as well as Supply Chain Management (SCM) in the industry.

Several studies from other industries (Mabert *et al.*, 2000, Tarn *et al.,* 2002; Akkermans *et al.,* 2003, Duplaga and Astani, 2003) have shown that the linkage between Enterprise Resource Planning (ERP) systems with Supply Chain Management (SCM) is becoming more obvious. According to Gartner Group another sign about growing interest between SCM and ERP is that old ERP systems will be replaced with ERP II systems where the emphasis will be in supply chain optimization trough collaboration instead of enterprise optimization. Also ERP II systems will include also functionalities developed in the unique needs of specific industry. ERP II will enable information sharing and transaction management across the supply chain better than its predecessor (Anon. 2001).

Hodge (2002) conducted a basic survey about ERP systems in the textile industry, where issues like, what functions are included in the textile ERP systems; what ERP systems was chosen, what functions are linked to ERP system, what were the main factors in system selection and what were the main barriers for implementation, were investigated. Hodge showed that sales, production control and material management were functionalities that were

most often implemented. Hodge argued that in the future textile companies are looking to integrate their existing ERP systems with SCM as well as business intelligence systems. This means that also in the textile and clothing industry there is an increasing awareness the possibilities that ERP solution could have in developing SCM practices and integration.

Similar implications can be also found from other studies. Mabert *et al.* (2000) conducted a survey on U.S. manufacturing firms concerning their ERP implementations, motivations for ERP implementation, strategic approaches of implementation, experiences of implementation, benefits and future directions. According to Mabert *et al.* ERP performance outcomes and areas of benefits emphasized the improved information processing efficiency and the SCM system was seen as an extension to the ERP in the future.

Only few publications (e.g. Tarn *et al.,* 2002, Akkermans *et al.,* 2003) discuss about the issues relating to both ERP and SCM. Tarn *et al.* (2002) reviewed rationales for ERP and SCM integration and according to them supply chain capabilities with ERP systems will continue to enhance in the near future. The main reason for this will be the cross-enterprise integration and integration of all core business processes through one comprehensive information system. Akkermans *et al.* (2003) conducted a Delphi study on the future impact of ERP systems to SCM. This study showed that on-going changes in supply chains require flexibility from IT. According to Akkermans *et al.* ERP will have a modest role in improving future supply chain effectiveness and ERP can have a clear risk by limiting progress of SCM. However, according to the study ERP can have contribution to issues like mass customization of services and products and standardization of processes and information. ERP systems can provide also greater transparency to the marketplace.

In addition, studies concerning SCM integration as well as integration between SCM and ERP have provided interesting aspects and thus increased interest towards integration. Several sources provide different kind of classifications to supply chain integration from different perspectives (Stevens, 1989; Bechtel and Jayaram, 1997; Romano, 2003; Huang *et al.,* 2003). Romano (2003) describes two different integration levels: intra-company integration, where the focus is to describe internal processes and inter-companies integration, but also external factors are considered. In addition, Bechtel and Jayaram (1997) identify four different forms of integration: integration on operations, integration of logistics operations and interfaces, integration of information, and integration of business processes. Integration can be seen

also from different angle. Huang *et al.* (2003) discovered three levels of enterprise application integration between ERP and SCM: data integration, application integration and business process integration.

Chiplunkar *et al.* (2001) provide yet another aspect to the information integration. They developed an integrated information management model for textile industry; because they have noticed that during past decades many organizations have tried to implement integrated information systems, like ERP systems, in order to improve co-ordination of information and therefore activities between different departments. Chiplunkar *et al.* argue that many industries, including textile industry, have find it difficult to implement ERP systems due to the amount of work involved, needs for customization and high costs reported during implementations. The integrated information management model is divided into seven modules: (1) finance, (2) production, (3) materials, (4) sales, (5) manpower, (6) quality assurance, and (7) system administration. The structure of this model follows mainly the structure of many ERP solutions. The integration model focuses on integrated information management in order to improve effectiveness of production and streamlining it, but also it aims to provide tools for business analysis for information system development.

Even though there is reasonable lot research conducted in SCM as well as ERP, there is little research addressed to the critical issue of integrating SCM with ERP in real business cases. There are also weaknesses in the research of possible limitations of ERP systems as well as possibilities in SCM. Also the role of ERP in SCM has been mainly uncovered, especially in the textile and clothing industry. In the rapidly changing business environment in the textile and clothing industry creates an ideal subject to explore the integration types and strategies between ERP and SCM.

1.2 Objectives of the study

The main objective of this study is to investigate Enterprise Resource Planning (ERP) softwares in the textile and apparel industry. The theoretical part of this study introduces the ERP with its functionalities and possibilities. It will also provide a general overview to SCM and its integration with ERP, while the theoretical part introduces different types of integration and what kinds of integration strategies have been founded. The objective of the

empirical part of this study is to examine what kind of ERP solutions have been chosen in the textile and apparel industry, what functionalities are included in implementation and what kind of benefits implementation have provided. In addition to this, SCM practices and strategy and the level of integration will be explored. The goal is to find out how well ERP system support the business processes in more complex network of suppliers, subcontractors and customers. The goals of theoretical and empirical of this thesis can be listed following way:

1. To describe the nature, functionalities and benefits of ERP software.

2. To describe and explain the concept of SCM in order to understand the use of information technology supporting it.

3. To review possibilities ERP provides in integration

4. To create an evaluation framework for empirical research based on previous studies and literature.

5. To review with the help of evaluation framework ERP systems, SCM and integration in the textile and clothing industry.

In this study concept of ERP is mainly examined from integration and SCM perspective. In addition to this ERP is seen as a modular system that supports key business processes. The main reason for this approach is the fact that for achieving external integration within the supply chain, also internal integration must be considered.

1.3 Research Methodology

The chosen research method will be based on qualitative analysis while both previous ERP and SCM research have strongly focused mainly on studying applied practices. The aim is to get a deeper insight for the subject, which can be considered sometimes confidential and strategical. According to preliminary interviews and the researcher's own experience, case study would be most beneficial from different qualitative methods. Yin (1984) defines case

study following way: it investigates a contemporary phenomenon within its real-life context. Case study is used especially when the boundaries between phenomenon and context are not clearly evident and it normally applies multiple sources of evidence. While, both ERP and SCM research have strongly focused on studying practices applied in companies.

Case study can be divided into seven stages (modified from Eisenhart, 1989 and Yin, 1989): (1) Determine and define the research questions, (2) Screening and select the cases, (3) Determine data gathering and analysis techniques, (4) Prepare to collect the data, (5) Collect data in the field, (6) Evaluate and analyze the data, and (7) Prepare the report. In the first stage the research questions and therefore also objectives were determined. These are described in section 1.2. Screening and selection of case started with collecting different kind of material of ERP implementation and information system development in the textile and clothing industry. First, preliminary interviews were conducted with three different companies in the industry, MASI Company Oy, Everdeal Oy and Naisten Pukutehdas Oy, in order to gather some information about ERP implementations and use of the application as well as different supply chain strategies. In addition, also secondary material was collected, including trade magazine articles, journal articles, companies' website information, press releases and company reports. Then, information about different ERP vendors, industry specific ERP solutions and generic ERP solutions with industry specific functionalities were collected. During this phase one industry specific ERP called Dafo was reviewed and system vendor, WM Data, was interviewed. Thirdly, during this screening stage also international companies were investigated. Two international companies, VF Corporation and Zara, were chosen for more careful analysis. At this point their supply chain strategies as well use of information technology were analyzed. This information gathered during screening and selection phase was use to integrate four pilot cases: Naisten Pukutehdas Oy, Everdeal Oy, Zara and VF Corporation. These pilot cases were used then in determining data gathering and analysis techniques and preparation of data collection. Finally, the framework for evaluating and analyzing ERP, SCM and integration was created according to previous studies, literature and pilot case studies.

According to information gained during the second stage MASI Company was chosen for more detailed analysis. The preliminary interview notes, transcripts and secondary material were used both during the preparation of data collecting as well as integrating the final case. In addition, MASI Company provided some additional material, including two theses

concerning development of their production management and ERP implementation process. Finally, all the data was evaluated and analyzed in order to integrate the final case study. The evaluation framework was applied in order to draw comprehensive picture about the role of ERP in SCM and integration.

1.4 Outline of the Study

This thesis is divided into six sections. Chapters 2 and 3 are focusing to the background and theoretical basis of the study. First, chapter 2 called Towards Integration outlines the development towards integration. First, the concept of Enterprise Resource Planning (ERP) is described. The chapter will introduce the evolution and the nature of ERP system. Then, chapter 2 presents the concept of Supply Chain Management (SCM) and different ways to see integration in the supply chain. Thirdly, chapter 3 reviews industry specific aspects of this study. This chapter introduces several aspects to the Finnish textile and clothing industry, explores the recent changes in the industry as well the challenges it will be facing in the future. Also the European and global changes in the industry will be presented in order to draw extensive picture about the industry. This chapter focuses also to supply chain management strategies in the textile and apparel industry, introduces ERP systems that are applied in the textile and clothing industry.

Then, chapter 4 describes the research methodology. Chapter 5 introduces the empirical part of thesis. First, chapter 5 introduces four pilot cases: Naisten Pukutehdas Oy, Everdeal Oy, Zara and VF Corporation. Then, this chapter introduces the theoretical framework created on a basis of literature, previous research and pilot cases. Finally chapter 5 reviews case MASI Company. Finally, chapter 6 discusses the findings of the study and as well as describes some directions for the future study.

1.5 Key Terms

APS	Advanced Planning and Scheduling
BI	Business Intelligence
CAD	Computer Aided Designs

CAM	Computer Aided Manufacturing
CIM	Computer Integrated Manufacturing
CPFR	Cooperative Planning, Forecasting and Replenishment
CRM	Customer Relationship Management
DC	Distribution Center
DW	Data Warehouse
ECR	Efficient Consumer Response
EDI	Electronic Data Interchange
EIS	Executive Information System
ERP	Enterprise Resource Planning
ICT	Information and Communication Technology
JIT	Just in Time
MIS	Management Information System
MRP	Material Resource Planning
MPR II	Manufacturing Resource Planning
PDM	Product Data Management
PLM	Product Lifecycle Management
POS	Point of Sale
QR	Quick Response
SCM	Supply Chain Management
VMI	Vendor Managed Inventory

2. Towards Integration

This chapter presents the issues that have been influencing the development towards integration in business processes and in IT systems. In this study concept of ERP is examined from integration and SCM perspective. In addition to this ERP is seen as a modular system that supports key business processes, more complex network of suppliers, subcontractors and customers. The main reason for this approach is the fact that in order to achieve external process integration within the supply chain, also internal integration must be considered.

This chapter is organized in the following way. Next, in section 2.1 the concept and the evolution of different planning systems are explored. Section 2.2 introduces the modular nature of ERP and how it is applied and what kind of benefits has been achieved. In the section 2.3 concept of Supply Chain Management (SCM) is defined and reviewed. Then, section 2.4 presents integration of ERP and SCM, including integration strategies, objectives and possibilities. Finally, the role of information systems in integration and coordination is explored by presenting different kind of aspects.

2.1 The Evolution of Enterprise Resource Planning

This section introduces the concept, evolution and maturation of Enterprise Resource Planning (ERP) through out system development and time. This overview of the history will show how the current ERP applications have developed. This will help to understand the nature and functionalities of ERP systems have today as well as the directions for the future development.

Different kind of definitions for ERP can be found from literature. Kumar and Hillegersberg (2000) describe ERP as a configurable information system package that integrates information and information-based processes within and across functional areas in an organization (Kumar and Hillegersberg, 2000). Davenport (2000, p.5) defines ERP as a system that supports organization information needs and business activities. Nowadays ERP systems have moved towards supporting supply chain optimization, sales force automation and customer service (Davenport, 2000, p.6). Also Somers and Nelson (2003) support the

business process and information integration view when they argue that ERP system provides help to organizations to manage supply chain, inventory, customer orders, production planning, shipping, accounting, human resources, and other business functions.

Kumar and Hillegersberg (2000) describe the development process of ERP as an inside-out process of evolution. The process have started from inventory control (IC) packages, to Material Requirement Planning (MPR), Manufacturing Resource Planning (MRP II) to finally Enterprise Resource Planning (ERP) systems. These ERP systems include, in addition to MPR II, also wide variety of enterprise functions, like sales and order management, marketing, purchasing, warehouse management, financial and managerial control and human resource management. The evolution is still continuing towards extended-ERP systems, where also inter-organizational processes are included.

Sumner (2005, p. 3) describes the evolution of ERP with the changing focus and purposes of information systems during decades. According to Sumner the maturation of ERP has started from 1960s from reorder point systems. The purpose of these systems was to help in forecasting future inventory demand by using historical data. The system was designed to manage high-volume production with a few products and constant demand. During the 1970s Material Requirements Planning (MPR) systems were developed. Focus moved towards marketing with emphasis on greater production integration and planning. MPR systems offered a demand based approach for planning manufacturing and ordering inventory.

According to Sumner during the next decades the emphasis moved from inventory management towards operations planning. MPR-II, meaning Manufacturing Resource Planning Systems, emerged in 1980s and in addition to its predecessor; it had capacity planning including possibilities for scheduling and monitoring the execution of production plans. System focus had moved towards quality management, process control, reduced costs and detailed cost reporting. During the 1990s MPR-II was embedded with manufacturing execution systems in order to meet customers' specific needs by adapting production schedule and creating new products and services. Finally, ERP systems emerged in late 1990s and the focus has moved towards integrating supplier, manufacturer and customer data in the whole supply chain. ERP systems were designed to integrate company's business processes in order to create seamless information flow from the supplier until the distribution to the customers.

Møller (2005) presents a view of evolution of ERP that supports opinions of Sumner and Kumar and Hillegersberg. According to Møller the evolution has started already in 1950s from inventory control systems (ICS) where the functions were related to forecasting and managing inventory. During the next decade Material Requirement Planning (MPR) was developed and functionalities were aiming to correspond to requirement calculations based on bill-of material (BoM). Increased need of planning caused a development of Manufacturing Resource Planning (MPR II) during 1970s and via Computer Integrated Manufacturing (CIM) during the 1980's and in the 1990s the ERP systems were develop in order to improve the integration of the processes.

In addition, Weston (2003) explores the recent development ERP systems. It seems that systems are moving towards ERP II, also called Extended Enterprise Systems. This outlook supports Sumner's view of future development of ERP systems. In addition with the previous systems, ERP II includes both Customer Relationship Management (CRM) and Supply Chain Management (SCM) system functionalities. The reasons for this development can be seen in the need to move data anywhere, at any time, within the company, within the value chain (customers, vendors) knowing that data are up-to-date and accurate, and independent of language, location, and currency. Increasing need for adaptability, flexibility, and responsiveness is influencing to the development towards ERP II systems. Adaptability refers to the enterprise ability to change or reconfigurate its business processes. By flexibility it is meant that enterprise has ability to integrate acquired firms, their accounting processes and new braches, plant and distribution centers from the very beginning. Responsiveness refers to enterprise possibility to answer to customer requirements quickly. According to Weston there are four main issues that will have impact to the ERP II in the future: (1) the meaning of fluent information flow will be increasing, (2) differentiated ERP II solution with a revenue, cost, or customer impact will gain market shares, (3) different kind of Web services that are enabled by the ERP II, and (4) relative success of supporting services and technology, e.g. application service providers (ASP).

Davenport and Brooks (2004) support also the idea of development of ERP systems towards supporting SCM. However, it seems that connecting complex information and business processes have been more difficult that generally has been anticipated. The development has been driven by the technological development, e.g. Internet and the rising emphasis of more efficient supply chains.

According to definition of ERP (e.g. Kumar and Hillegersberg, 2000; Davenport, 2000; Sumner, 2005) they are information systems that support business processes and free flow of information within and between organizations. Evolution of ERP systems has shown that development has been moving towards integration of information and business processes. In the future the emphasis of the development will be in integration of supply chains by adding supporting functionalities to the systems. Acquiring and implementing of ERP systems is often aiming to increase efficiency by integration and organizations are expecting to achieve great benefits from expensive and extensive implementations.

2.2 The Nature of Enterprise Resource Planning

This section discusses the nature of ERP, focusing on business process supporting and modular nature of ERP systems. The section also reviews the benefits that have been gained from implementing ERP. The objective for this review is to understand the possibilities that these systems provide in internal and external integration.

According to Davenport (2000, p. 135) ERP systems are distinguished for their orientation to broad cross-functional business processes and common information. ERP systems support free information flow between organization's key business functions. Several years have enterprises wanted to integrate their information systems across processes. Davenport (2000, pp.138-139) suggests that the typically supported processes are:

- All financial and accounting processes
- All supply chain processes
- All manufacturing processes
- Customer and order fulfillment processes
- Customer service processes
- Sales force processes
- Human resource processes
- Maintenance of plant and equipment
- Construction and project management
- Some management processes

Most of the ERP systems are modular and thus enabling companies to choose which functionalities they will implement. Davenport (1998) suggests that mostly implemented modules are finance and accounting, whereas only few companies implement others, like module for human resource management. Sometimes a company simply doesn't need some modules offered, like service business doesn't adopt modules for manufacturing.

Table 1. ERP Modules in U.S manufacturing firms (Mabert *et al.,* 2000), in the textile and apparel industry (Hodge, 2002) and in Swedish manufacturing firms (Ollhager and Selldin, 2003)

	U.S manufacturing firms	Textile and apparel industry	Swedish manufacturing firms
Financial Accounting	**91,5 %**	56,0 %	87,3 %
Material Management	**89,2 %**	**96,0 %**	**91,8 %**
Production Planning/ Control	**88,5 %**	**96,0 %**	90,5 %
Order Entry/ Sales	87,7 %	**88,0 %**	**92,4 %**
Purchasing	86,9 %	8,0 %	**93,0 %**
Financial Control/ Controlling	81,5 %	48,0 %	82,3 %
Distribution, logistics, warehousing	75,4 %	8,0 %	84,8 %
Asset Management	57,7 %	N/A	63,3 %
Quality Management	44,6 %	52,0 %	47,5 %
Personnel/ Human Resources	44,6 %	12,0 %	57,6 %
Plant Maintenance	40,6 %	24,0 %	44,3 %
R&D Management and Product Engineering	30,8 %	48,0 %	34,4 %
Project Management	N/A	36,0 %	N/A
Executive Information Systems	N/A	40,0 %	N/A
System Administration	N/A	48,0 %	N/A
Other	9,8 %	N/A	N/A

Studies about ERP implementations (Mabert *et al.,* 2000; Hodge, 2002; Ollhager and Sellding, 2003, Duplaga and Astani, 2003) support Davenport's suggestion about the

processes that ERP is meant to support. Especially the role of ERP in material management and in financial accounting is apparent. According to several sources (e.g. Mabert *et al.*, 2000; Hodge, 2002; Ollhager and Sellding, 2003) firms in manufacturing, also in the textile and apparel industry prefer to apply ERP in material management, order entry and sales and production planning and control (table 1). However, comparing the textile and apparel industry with Swedish and U.S manufacturing firms, financial accounting is more frequent in these manufacturing firms.

Table 2. Before and After ERP: Business Standpoint (Sumner, 2005, p. 4)

	Before ERP	With ERP
Cycle time	Costly bottlenecks	Time and cost reduction of business processes
Transaction processing	Multiple transactions use multiple data files	Faster transactions, using common data. Reduces the time and cost of multiple updates
Financial management	Increased cost of excess inventory, cost of overdue accounts receivable	Improves operational performance (e.g., less excess inventory, reduction in accounts receivable)
Business processes	Proliferation of fragmented processes with duplication of effort	Re-engineering around a business model that confirms with "best practices"
Productivity	Lack of responsiveness to customers and suppliers	Improvements in financial management and customer service
SCM	Lack of integration	Linkages with suppliers and customers
eBusiness	Web-based interfaces support isolated systems and their components	Web-based interfaces are front-end to integrated systems
Information	Lack of tactical information for effective monitoring and control of organizational resources	Allows cross-functional access to the same data planning and control. Provides widely available information
Communication	Lack of effective communications with customers and suppliers	Facilitates organizational communications with customers and suppliers

According to Davenport (2000) despite of difficulties in implementing ERP several benefits can be listed. Examples from cycle time reduction, faster information transactions, improved financial management, improving information visibility by making tacit process knowledge explicit as well as making the foundation for electronic commerce have been reported.

Sumner (2005, p. 6) suggests that the tangible benefits of ERP are lower inventory levels, improved on-time delivery, and decreased financial closing cycles. Sumner (2005, p.4) lists business standpoints before and after ERP (table 2). ERP can have positive impact to cycle time, transaction processing, financial management, business processes, productivity, SCM, e-Business implementation, information availability and accessibility and communication.

ERP solutions have been criticized about their poor applicability to SME enterprises. Most of the Finnish apparel and textile companies can be considered as small and medium size enterprises (SME) (Finatex, 2005). This sets a certain kind of difficulties to apply gigantic ERP- systems. These systems are often considered inflexible, their implementation takes a lot of time, ERP systems are considered too hierarchical. In addition with limited resources in small organizations and therefore personnel can be reluctant for big IT projects (Davenport, 2000).

Despite of criticism, several benefits for implementing ERP system can be listed (e.g. Davenport, 2000; Sumner, 2005). Benefits can be reviewed from different perspectives, but from business standpoint the most important improvements are related to key business processes by increasing information visibility and availability. In addition with increased efficiency in financial management and transaction processing, cycle time reduction, improved productivity, ERP systems help to improve SCM by increasing integration with suppliers and customers.

2.3 Concept and theory of Supply Chain Management

Nowadays, changing markets and customer demands, short products life cycles, and global competition characterize business environment in every industry. More efficient supply chains are one way to improve the performance. In more challenging business environment, development of information technology has enabled many improvements in managing supply chains.

Ganeshan and Harrison (1995) define supply chain as a network of facilities and distribution options that performs the functions of procurement of materials, transformation these materials into products and finally distributing these products to customers. Supply chains

exist in both service and manufacturing organizations and the complexity of the supply chain may vary greatly between industries as well as between enterprises. If the supply chains can vary greatly, the fundamental question is how can be Supply Chain Management (SCM) then defined.

Supply Chain Management (SCM) can be defined from different perspectives. It can be seen as management philosophy, set of activities to implement a management philosophy or set of management processes (Mentzer *et al.,* 2001). According to Lambert *et al.* (1998) by SCM business processes across supply chain are integrated and managed and it offers the opportunity to capture synergies from both intra- and inter-company integration and management. Simchi- Levi *et al.* (2003) define SCM as a set of approaches that are used to efficiently integrate suppliers, manufacturers, warehouses, and stores in order to deliver right quantities, to right location at the right time with minimum costs and satisfying customer service level.

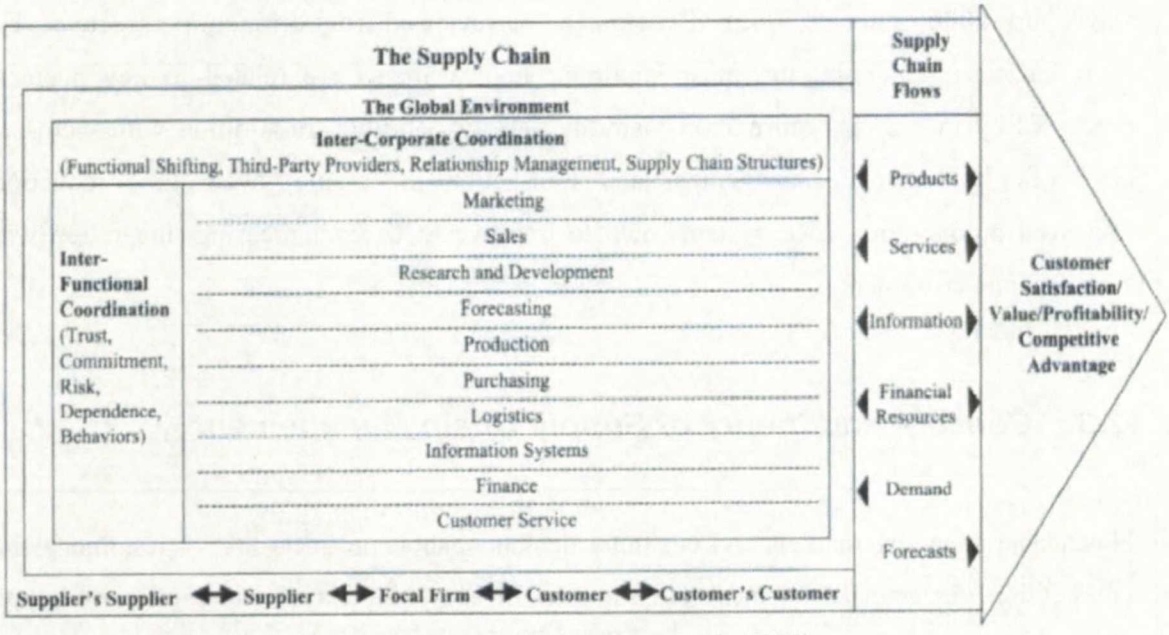


Figure 4. Supply Chain Management model (Mentzer *et al.,* 1999).

Mentzer *et al.* (2001) introduced approach to SCM from value chain perspective where both inter-corporate coordination as well as inter-functional coordination are in essential role (figure 4). The role of SCM in the global environment is to achieve customer satisfaction by the value attained in profitable and competitive way. Mentzer *et al.* lists seven activities that are necessary to successful implementation a SCM philosophy: (1) Integrated behavior, (2)

Mutually sharing information, (3) Mutually sharing risks and rewards, (4) Cooperation, (5) The same goals and the same focus on serving customer, (6) Integration of processes, and (7) Partners to build and maintain long-term relationship.

Cooper *et al.* (1997) introduce a broader understanding to the SCM concept with expanding the traditional business process to supply chain business processes that are linked across intra- and inter-company boundaries (figure 5). Along with these elements of SCM framework, it includes the decisions concerning management and the level of integration applied in process links between supply chain members. The framework considers also important issues of supply chain network structure including decisions about the key supply chain members with whom to link key business processes.

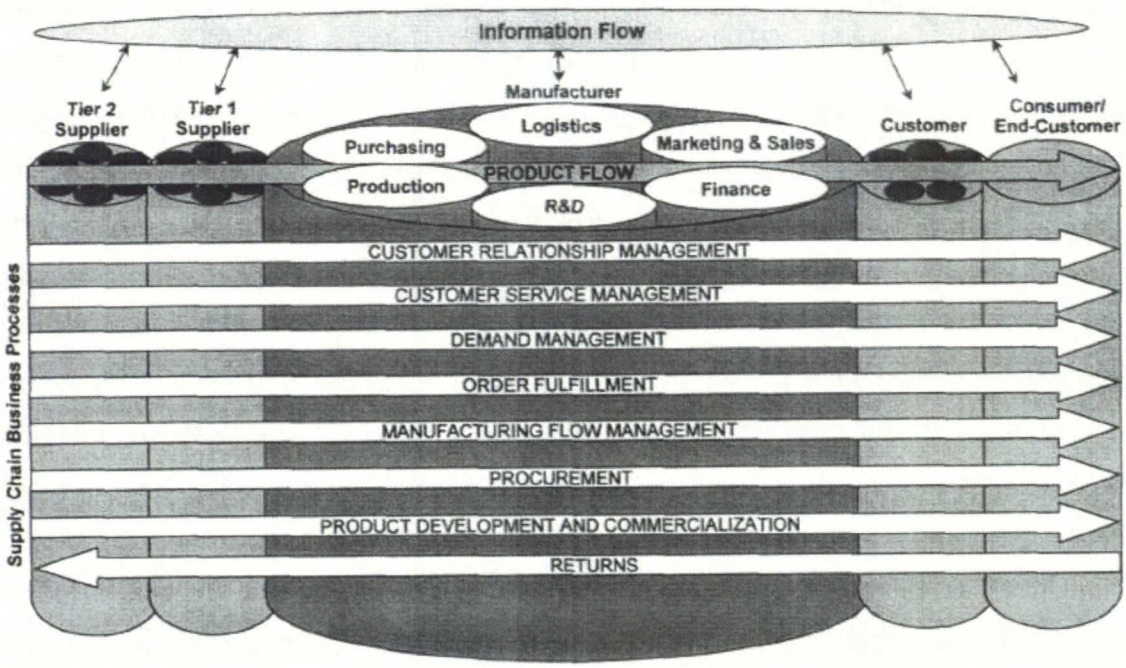


Figure 5. Supply Chain Management: Integrating and managing business processes across the supply chain (Cooper *et al.,* 1997).

Even though there are several different ways to determine the concept of SCM, all definitions emphasize that SCM is aiming to provide benefits to all members of supply chain. Different SCM models include two essential themes: integration and coordination. These help to increase the efficiency of the whole supply chain by improving the information sharing in

business processes. Both internal and external integration and coordination are considered important part of successful SCM.

2.4 Integration and Coordination in Supply Chain Management

The development towards integration in SCM has been driven by several factors. First, many companies have been implemented ERP systems and spent lot of money and time in order to improve efficiency of their business processes. Thus, with ERP systems information sharing with suppliers and customers can be much easier. However, many companies are still unclear on how they will leverage all this integrated information into real competitive advantage. Secondly, the Internet has given new kinds of possibilities to supply chain thinking. Electronic Data Interchanged (EDI) has existed already for couple of decades providing possibilities to link industrial vendors with their customers. However, EDI has been heavily concentrated among large companies. Today, more powerful and integrated packaged solutions, mainly applying Internet, can be acquired. Thirdly, rise of packaged supply chain softwares have been also driven towards current development more integrated supply chains (Davenport and Brooks, 2004).

Sumner (2005) emphasized that integrating the supply chain requires commitment to strategy, process, organization and technology. First of all strategic objective in integrating the supply chain is to align SCM with the overall business directions. Secondly, from the process point of view, also business processes should be integrated and linkages should be established with suppliers and customers throughout the supply chain. Third issue that should be considered is an organizational integration where organizational units should be integrated and the level of cross-functional integration should be defined. Finally, advanced communication and data integration are technology factors, which should be considered as enabler of supply chain integration.

Several sources from different perspectives acknowledge that one of the most important issues in SCM is integration (e.g. Christopher, 1992; Lambert *et al.,* 1998; Kulp *et al.,* 2004). In addition with recognizing the possibilities that IT can provide in integration process, also the current integration level should be identified. Literature (e.g. Romano, 2003; Bechtel and

Jayaram, 1997; Huang *et al.,* 2003; Stevens, 1989) reviews different ways of categorize and classify the level and stages of integration.

Supply chain integration can be classified by different ways. Bechtel and Jayaram (1997) identify four different forms of integration: (1) Integration on operations, (2) Integration of logistics operations and interfaces; (3) Integration of information; (4) Integration of business processes. In addition, Bowersox *et al.* (1999) classified integration in a supply chain into six different types: (1) customer integration, (2) internal integration, (3) material and service supplier integration, (4) technology and planning integration, (5) measurement integration, and (6) relationship integration.

Romano (2003) describes yet another way integration level He divides integration to two different levels: Intra-company and inter-company integration.

- *Intra-company integration*, aiming to overcome the functional silos boundaries, and relating to activities to manage and re-design the business processes across individual members of supply network (e.g. functional integration, rationalization of internal processes, integration of internal information systems).
- *Inter-companies integration*, aiming to overcome the individual company boundaries, and relating both an initial extent of integration and to an advanced extent of integration, or "supply network integration".

However, intra-company integration is a pre-requisite for inter-companies integration. It seems that one of the major obstacles to fully integrating materials and information flows across the supply network lays in the inadequacy of internal management systems of the individual firms, including lack of standardization and data integrity, high level of fragmentation in information flows, lack of integration among different information systems inside the company, interconnection difficulties, low level of rationalization and standardization in operational processes (Romano, 2003).

Lee (2000) outlines three dimensions of supply chain integration: (1) information integration, (2) coordination and resource sharing and (3) organizational relationship linkage. Information integration is based on information and knowledge exchanging by the means of information sharing, collaborative planning, forecasting and replenishment. In coordination and resource sharing decision-making and delegation, work realignment and outsourcing are applied. The

essential issues in organizational relationship linkage are shared risks, costs, and gains by using extended communication and performance measures as well as incentive realignment.

Different from previously introduced ways of classifying integration levels are Stevens' theory (1989), Bagchi and Skjoett- Larssen (2003) approach and SAP AG's Stages of Excellence –model. These see integration through development, which goes through certain stages of SCM.

According to Stevens a company is in first stage of integration when it has an independent operation of each function, such as sales, manufacturing, planning, material control, and purchasing. In the second stage functional integration can be observed, meaning that a company has limited integration between functions such as shipping and inventory or purchasing and raw material management. Focus in this stage is more in cost reduction than performance improvement. In the third stage all internal functions are connected and integrated. This stage is characterized by full system-visibility and the focus is more tactical than strategical. When a company reaches the fourth stage of integration also external integration has been achieved by encompassing also suppliers and customers. Focus has moved towards strategical.

According to Bagchi and Skjoett- Larssen (2003) supply chain integration stage can be divided into three levels: *low, medium,* and *high integration* (table 4). In their study key issues in supply chain integration are integration of information technology and organization, correlation between IT capabilities and integration level. Table 4 introduces the different modes of supply chain integration and what kind of systems or technology is applied within a certain stage of integration. This classification combines different kind of supply chain practices with information and as well as IT system integration.

Table 4. Stages of Information Integration (Bagchi and Skjoett- Larssen, 2003)

Supply Chain Integration Using	LOW Integration	MEDIUM Integration	HIGH Integration
Transaction system	MPR II Systems Legacy Systems	ERP systems - Intra-company - Rigid Interfaces Value: Mechanization of existing processes	ERP and Supply Chain Planning (SCP) systems - Intra-company - Flexible Interfaces Value: Process Improvement
Communication systems, Internet/ Extranet	E-mail/Fax/phone Internet/Extranet only used for limited purposes	Few EDI/Internet links to customers/suppliers Extranet	Extensive use of EDI/ Internet/XML links within supply chain
Bar-coding and Track – and- trace Systems, Electronic POS Data Capture, Inventory Visibility	One bar-coding of finished products Track- and – trace and Electronic POS not used	More extensive bar-coding, automated e-mail updates and confirmations	Bar- coding from entry to dispatch Track- and- trace throughout the supply chain Key suppliers and customers connected
Vendor Managed Inventory (VMI) Collaborative Planning, Forecasting and Replenishment (CPFR) Customer Relationship Management	Not used	Experimental stage with one or a few supplier/ customers	Strategic suppliers have access to production plans, material requirements, sales forecasts and orders CPFR/VMI with key suppliers/Customers CRM with key customers

One of the biggest ERP vendors, SAP AG, has developed a "Stages of Excellence" model, which has been developed for evaluating a company's stage of development in IT and its impact to SCM. This division reminds classifications of Bagchi and Skjoett- Larssen introduced earlier. The Stages of Excellence are divided into four levels (table 5): *Disconnected Systems, Interfaces, Integrated Internally* and *Multienterprise Integrated.* In this model different parts of a company's business may be in different stages of development. This model defines the IT capabilities of an organization in each stage and its advantage is that it can help to evaluate current development and to identify where other companies are heading and where might the future competitive advantage lie.

Table 5.SAP Stages of Excellence

Stage Capability	I: Disconnected	II: Interfaces	III Integrated Internally	IV: Multienterprise Integrated
Internet	Visibility	Catalogs	Exchanges	Unattended trading
Integration	None	Batch	Inter-enterprise	Supply chain network
Supply Chain Planning	None	Informal demand planning	Formal global demand planning	Integrated global planning
Production Scheduling	None	Basic MRP	Constraint- based	Advanced planning systems (APS)
Integration with Suppliers	FAX/phone	EDI/FAX/ phone	EDI with all large suppliers	VMI, online RFQ
Customer Delivery	Research	Local inventory	Available to promise (ATP)	Capable to promise (CTP)

Stage I. Disconnected Systems

Companies at stage I are characterized by the proliferation of many independent systems, manual and inefficient communication, and digitized internal data. The focus with these companies is to automate existing functions and tasks. Company's organization structure can be characterized as a functional and the level of integration is low and Web capabilities are non-leveraged. Organizations are focusing standardization of internal processes and address Internet readiness. For stage I following characteristics can be listed:

- Functional strategies
- Lack of clear, consistent supply chain management processes
- Lack of qualified supply chain leadership
- Disconnected systems
- Measurements lacking or not aligned with company's objectives

Stage II. Internal and External Interfaces

At stage II, companies are still organized functionally, but the level of integration is higher. These companies operate with functionally focused e-business solutions, disparate information systems, functional flow through of data and decentralized external links. Information exchange and interaction with trading partners is done via Internet. At this stage companies tend to be transaction focused on both buy-side and sell-side activities. For stage II following characteristics can be listed:

- Integration of some functional information to decrease inventory and improve efficiency
- Documented processes that are followed
- Leaders who are supply chain professionals, and people providing data are well directed
- Systems that are connected and generally provide accurate information about what is needed and where
- Key measurements that are used departmentally

Stage III: Internal Integration and Limited External Integration Efficiency

At stage III companies are cross-functionally organized and are operating with integrated systems within enterprise and limited external value chain integration. One-to-one trading partner interactions have been established. Organizations at this stage have more integration within supply chain: suppliers are linked to their back-end systems and buyers to their front-end systems. For stage III following characteristics can be listed:

- Visionary organization that integrates information from whole supply chain to plan product movement from supplier to customers
- Sophisticated processes that involve all affected organizations
- Visionary, professional leadership
- Highly capable systems that provide supply chain information to affected departments
- Sophisticated systems that provide real-time guidance

Stage IV: Multienterprise Integration

At stage IV companies are cross-functionally organized and operate with integrated systems within the enterprise and maximum external value chain integration. Issues like multienterprise systems and processes, common business objectives, seamless information

sharing, knowledge organization, and automated and interactive collaborations are typical for this stage. The value network is totally visible as a result of end-to-end integration. Collaboration links are established with trading partners and these enable them to operate as one virtual corporation. For stage IV following characteristics can be listed:

- Collaboration across the supply chain
- Internal collaborative supply chain management's focus on key service and financial goals
- Executive leaders who foresee needs for functional and process skills that affect the supply chain and proactively drive skills development
- Systems that integrate appropriate information across the whole company
- Fully integrated performance management systems that links supply chain results to company goals.

In addition, coordination is an essential theme in SCM along with integration. As introduced earlier in figure 4. coordination can be divided into inter-corporate and inter-functional coordination. According to Fisher (1997) all contributions and investments that aim to increase demand and synchronize supply can be considered as coordination. Akkermans *et al.* (2003) divide coordination into three categories: (1) Information deployment, (2) Channel alignment, (3) Operational Flexibility. Information deployment can be seen as a joint decision making by using joint forecasting and schedule sharing along with applying POS data. Joint supply chain design and synchronizing can be considered as channel alignment. Operational flexibility is required in developing new operational models different parties in supply chain.

According to Simatupang *et al.* (2002) coordination between companies is a key to flexibility and continuous improvement of logistics process in continuously changing business environment. Thus, weak coordination between parties in supply chain may lead into operational inefficiency. Models like, Vendor-Managed Inventory (VMI), Quick Response (QR), and Collaborative Planning, Forecasting and Replenishment (CPFR) aim to increasing coordination between parties in supply chain and that way also improve information sharing, efficient product replenishments and thus improving efficiency the whole supply chain.

Integration and coordination are considered key factors in successful SCM. Especially defining, characterizing and classifying integration have been essential in many studies (e.g.

Bechtel and Jayaram, 1997; Bowersox, 1999; Romano, 2003). While integration is seen as an objective in efficient SCM, coordination is often seen as an activity that is aiming to increase efficiency of supply chain. However, both integration and coordination in SCM require appliance of suitable information systems.

2.5 Role of Information Systems in Integration and Coordination

According to several sources (Parnell 1999, Tarn *et al.,* 2002, Akkermans *et al.,* 2003, Bagchi and Skjoett- Larssen, 2003, Davenport and Brooks, 2004) focus in integration with the ERP solutions is mainly internal, and therefore in many cases companies must implement separate solutions in order to achieve more extended integration between enterprises. According to Simchi-Levi's (2003, p.244) objectives for information systems for effective SCM collecting information, providing visibility to operations and data access can be traditionally improve with ERP systems, while analyzing, planning activities and supply chain partner collaboration require normally more extensive IT architecture.

According to Simchi-Levi (2003, 244) information systems have an important role in effective supply chain management, from integration and coordination perspective. Information systems applied in SCM have different kind of goals and objectives that can be divided into four groups:

1. Collect information on each product from production to delivery or purchase point, and provide complete visibility for all parties involved.
2. Access any data in the system from a single point of contact.
3. Analyze, plan activities, and make tradeoffs based on information from the entire supply chain.
4. Collaborate with supply chain partners in order to manage uncertainty, e.g., through information sharing, and achieve global optimization.

Having their internal operations integrated, many organizations have moved towards developing supply chains with the help of their ERP systems (Davenport and Brooks, 2004) Whereas an ERP system focuses on internal business processes of an enterprise, SCM focuses on inter-enterprise cooperation with suppliers, subcontractors and customers. Parnell (1999) emphasize that ERP are transaction-based systems, while SCM systems are decision support

systems- they take in all or a set of these transactions and allow users to analyze the data in order to improve forecasts, manufacturing plans, or replenishment plans.

Based on prior research Narasimhan and Kim (2001) list twelve traditional uses for information systems in SCM: plant and warehouse location selection, order processing, resource management, production plan and process control, inventory and warehouse management, distribution and transportation management, sales and price management, consumer service and customer management, forecasting, network planning and design system, office information system, and accounting information system.

Gormley *et al.* (1997) divide SCM packaged softwares into four categories:

1. *Supply planning tools*, which help to align all the resources and activities, require getting the goods to market cost-effectively.
2. *Demand planning tools*, which help companies to anticipate market demand for their products with more precisely, thanks to sophisticated modeling and statistical analysis.
3. *Plant scheduling tools*, which translate overall supply requirements into day-to-day production plans.
4. *Logistics systems* for supporting warehouse management, inventory transportation, and order management.

Tarn *et al.* (2002) compare SCM and ERP application from four different aspects: objective, focus, goal and function (table 3). This analysis reinforces the traditional dichotomy: ERP systems are aiming to improve the internal efficiency by integrating different functions and parts of organization, while SCM focuses on external relationships. Along with ERP system communication and information flow between supply-chain agents is improving. Therefore, integration between ERP and SCM is a natural and necessary process taken into consideration both from managerial and strategic point of views. It is expected that in the future ERP will have a greater role in improving supply chain and fostering collaboration across multiple enterprises.

Table 3. Comparison of SCM and ERP systems (Tarn *et al.* 2002)

	SCM Application	**ERP Application**
Objective	Integrating and optimizing internal business processes of a single organization as well as the organization with its business partners across the entire supply chain	Integrating and optimizing internal business processes within the boundary of a single organization
Focus	Optimizing information flow, physical distribution flow, and cash flow over the entire supply chain.	Optimizing information flow and physical distribution flow within a single organization.
Goal	Constraint- based tool providing reasonable and feasible business plans based on the availability of the required key resources	Non-constraint- based tools providing business plans without the consideration of the availability of key resources.
Function	Manufacturing management, inventory management, logistics management, supply chain planning	Manufacturing management, financial management, human resource management

New markets in software business have emerged from integration of SCM modules into existing ERP solution. Tarn *et al.* (2002) separate three different kinds of integration methods for system integration: conformity, middleware and special integration software. Conformity –method requires that all of the members in the supply chain to embrace the same system. Secondly, in some cases links between different systems can be established by various systems via programming, i.e. middleware. Thirdly, special integration softwares can be extending ERP functionality and allowing ERP and other systems to share processes and data.

Huang *et al.* (2003) divide enterprise information system integration to three levels: (1) data integration, (2) application integration and (3) business process integration. Data integration requires compatibility of data definitions and encoding formats between the systems to be integrated. This means that ERP and SCM will be able to exchange transactions electronically while retaining their own platforms and databases. However, information exchange is not real-time, but normally done in batch formats. Redundancy of information

still remains, because each system still has own databases. Maintaining two separate systems causes higher costs in long-term. In application integration ERP and SCM systems are integrated at the program level. In this case use of a middleware is often necessary, because ERP applications are quite often customized to meet company's internal data processing needs. Integrating ERP and SCM at the application level gives trading partners access to each other's ERP systems, so this requires quite a lot of trust between partners. This might also include a risk; if the parameters are not carefully defined, mistakes in one company's system can contaminate the SCM system and that way influence to the functionality of the whole supply chain. Finally, business process integration goes beyond data and systems, thus creating frictionless information and material flow on supply chain. Business process integration can be divided into four layers: technical compatibility, operational compatibility, strategic compatibility, and political and legal environment compatibility.

Huang *et al.* (2003) recognize five different kind of strategies for integration: (1) selecting vendor with integrated solutions, (2) minimalist approach, (3) selecting compatible products, (4) using middleware and (5) custom programming. Choosing a strategy is influenced by the start situation of an enterprise. If a company is starting from a scratch, it should select vendor with integrated solutions. If existing corporate applications are being expanded with available products, most suitable strategies are minimalist approach were entire system is built from small independent but compatible components or by selecting compatible products. If no compatible products are not available, the most suitable strategy would be bridging the applications, which means either using a middleware or by custom programming.

Even though ERP systems can provide benefits in SCM, Akkermans *et al.* (2003) recognize four main limitations of current ERP systems: *lack of extended enterprise (EE) functionality*, *lack of flexibility in adapting to ever-changing supply chain needs*, *lack of more advanced supporting functionality beyond transaction management*, and *lack of open, modular, internet-like system architecture*. Lack of EE functionality was considered as the first and most prominent common treads to SCM, while current ERP systems are developed to manage product flows inside one enterprise and thus they are difficult to interconnect with other systems. At the same time further integration of activities between suppliers and customers across the entire supply chain was seen as a most important key issue in SCM. While the needs of supply chains are changing, maintaining flexibility in ERP systems can be limiting and challenging.

The role of information systems in SCM is evitable. According to literature (Tarn *et al.* 2002; Simchi-Levi, 2003, p.252; Davenport and Brooks, 2004) ERP systems have essential role in SCM by providing internal integration and being as a backbone of the company IT. In addition different kind of application can be implement in order to improve SCM. Different applications can be integrated both inside enterprise and externally in order to achieve greater integration in information and processes. Development of IT has provided many option to that.

3. Aspects to the Textile and Clothing Industry in Finland

During last years the Finnish textile and clothing industry has faced several changes in the local and global competitive environment. The typical news in Finland from the industry have concerned either bankruptcies, increased vertical integration or companies moving their production to low cots sites. Chapter 3 reviews industrial aspects of this study. This chapter examines the Finnish textile and clothing industry as a part of the European one but considers also local aspects. The industry specific characteristics, recent global changes and expectations for the future are also explored in order to understand the industry structure and its changes. Thus, future demands in the textile and clothing industry, including supply chain performance and information systems are introduced. This chapter reviews also different IT systems, including ERP and SCM solution vendors in the industry and system implementations. In addition the chapter introduces how different kinds of information systems have been applied in the Finnish textile and clothing industry in order to develop operational efficiency, especially SCM practices. The aim is to create evaluation framework for the empirical part of this study by integrating previously introduced theoretical part, this industrial review and the pilot case studies introduced later.

This chapter is organized as follows: first, in the section 3.1 the development of the textile and clothing industry during last decades is briefly introduced as well as the current business conditions of the industry. In addition ten biggest Finnish companies in the industry are listed. Secondly, section 3.2 is focusing exploring characteristics of the textile and clothing industry. Thirdly, in the section 3.3 future challenges are introduced and analyzed in order to create vision and understanding of the resources of competitive advantages in the future. Then, in section 3.4 taxonomy of textile and apparel information systems, including ERP, are described. This section introduces also integrated information management model for the textile industry, which can be applied for example in information system design in the textile and clothing companies. Fifthly, section 3.5 explores recent ERP implementations in the textile and clothing industry. Finally, section 3.6 reviews supply chain structure, management and strategies in the textile and clothing industry.

3.1 Development of the Textile and Clothing Industry

The European textile and clothing industry has a longstanding tradition in applying new innovation against fierce global competition. In year 2000 the industry employed nearly 2.2 million people with an annual turnover 195 billion Euro. The textile and clothing industry is still one of the major industrial sectors in Europe despite of the hard global competition and relocation of manufacturing to lower-wage countries. However, decreasing of the textile and clothing industry has been considerable in EU region, while according to the European Apparel and Textile Organization (Euratex) year 2004 was estimated to be lowest during last ten years in EU-15 countries (figure 1) (Euratex, 2002).

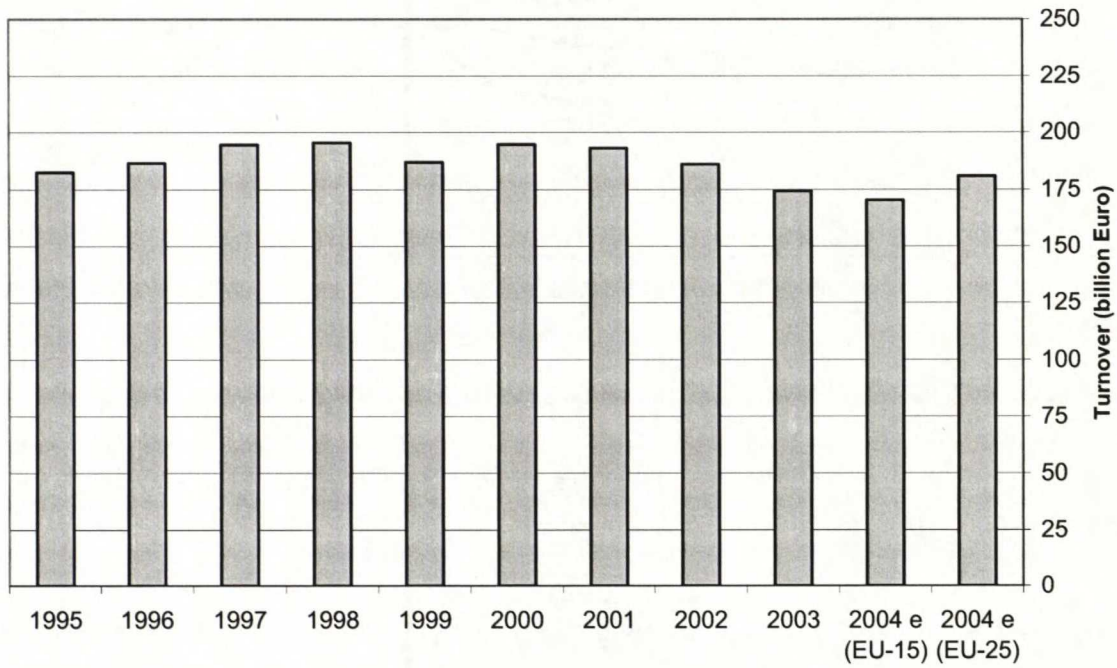


Figure 1. The textile and clothing industry's turnover development 1995-2004 in European Union (Source: Euratex).

According to Euratex the textile and clothing industry can be divided into three main sub-sectors, which are strongly connected to each other; manmade fibers, textiles and clothing. Manmade fibers represent 6%, textiles 55% and clothing 39% from the industry. In year 2000 EU-15 corresponded 20% of textiles and 10% of clothing world export. The Federation of Finnish Textiles and Clothing Industries (Finatex) divides the textile and clothing industry into two sub-sectors: manufacturing of textiles and manufacturing of wearable apparels. Share of the textile and clothing industry from a total manufacturing have been decreasing

during last years being 1.1% in year 2004. Textile manufacturing represents almost 60% of the whole textile and clothing industry. In year 2004 Finnish textile and clothing industry reached an annual turnover of 1.2 billion Euros. Manufacturing wearable apparels have been decreasing the whole 21. decade (figure 2). Especially during last years the development has been outstanding fast. While manufacturing industry and manufacturing of textiles has been growing through 90's, manufacturing of apparels has been dropping (Finatex, 2005).

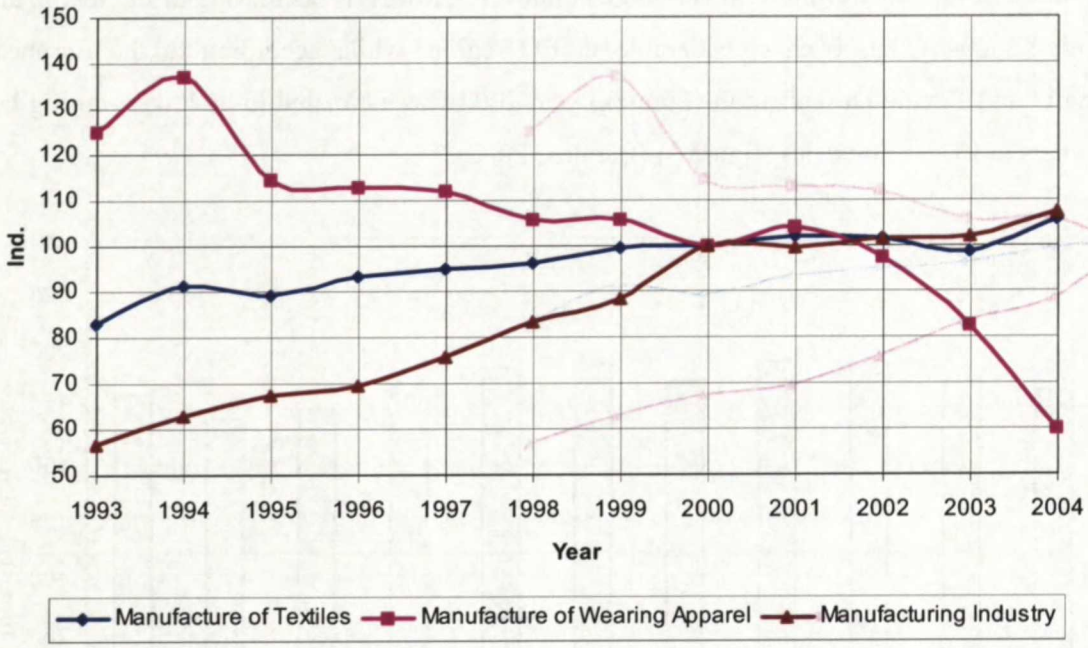


Figure 2. Volume Indexes of manufacturing textiles, wearing apparels and manufacturing industry (2000=100). (Source: Finatex, 2005)

Even though the most of the companies in the industry are considered SME's, recent years few bigger corporations have been dominating the Finnish textile and clothing industry. L-Fashion Group is the biggest company in the industry in Finland (table 7). After several loss-making years in year 2004 was finally profit-making for the company (Salo, 2005). Lat decade the most profitable and prominent company in the industry has been Marimekko, which has been able to grow fast. From the textile industry sector Tamfelt has been able to grow during last years and still make nice profits. Beside organic growth companies are also growing through vertical integration, mergers and acquisitions. In year 2000 L-Fashion Group bought retail chain called Aleksi 13 and in summer 2005 Nanso bought Vogue Group. Nanso is at the moment Finland's fourth biggest company in the industry and second biggest clothing company in Finland.

Table 7. Ten biggest companies in the textile and apparel industry (year 2004).

	Turnover (Million euros)	Net result (Million euros)	Equity ratio%	Personnel
L-Fashion Group	160	2.9	48	1 298
Tamfelt	134	12.5	65	1 325
Espe Group	77	1.8	28	551
Marimekko	65	5.9	61	375
Nanso	47	2.2	48	485
Virke	31	1.1	47	502
RTO Holding (Reima Corp.)	30	0.3	15	331
Vogue Group	28	1.0	29	374
Turo Tailor	23	-0.2	36	207
MASI Company	15	N/A	N/A	150

3.2 Characteristics of the Textile and Clothing Industry

Changes in global economics have had consequential impact to the textile and clothing industry in European countries, including Finland. Thus, there are also several characteristics that can be considered typical to the textile and clothing industry. These kinds of characteristics are small enterprise size, complex industry structure and high level of specialization. With the industry characteristics, also product related issues have impact to the operation models applied within the industry. However, the textile and clothing industry is highly diverse and heterogeneous (Bruce *et al.*, 2004).

Along with the rise of costs, including wages and operational costs in one country, the textile and clothing industry have traditionally moved tasks, especially those with low value-added such as garment assembly, to lower cost sites (Taplin and Winterton, 2004). While materials and finished products can be delivered from all over the word, complexity of industry structure and production networks are increasing. Taplin and Winterton suggest that as long as clothing manufacturing continues to be an industry with low level of technical innovation

and minimal capital requirements, the barriers to entry will remain low, and jobs will eventually migrate to low labor cost sites.

The European textile and clothing industry is dominated by small and medium size enterprises. According to Euratex (2002) 95% of the European textile and clothing companies are considered as small or medium size enterprises (SMEs). The rate is even higher in Finland, while according to Finatex 97% of its members can be considered as SMEs. Especially apparel manufacturing is dominated by small, family owned companies. Companies that employ less than five employees represent 80 % of all companies, but only little over 10% of the annual turnover (Haimakainen *et al.,* 2000).

In addition to increasing global sourcing and small enterprise size, complex industry structure is caused also by the wide use of subcontracting. According to Finnish Ministry of Trade and Industry 57% of textile companies and 39% of clothing companies are using subcontracting. Surprisingly, many of these companies are also subcontractors for other companies, because 41% of textile companies and 23% of clothing companies have been subcontracting to other companies in the industry (Tevanake-toimialabarometri, 1999).

The textile and clothing industry is often considered as a one industry sector due to the fact that sub-sectors, apparel and textile manufacturing, are quite often linked within the same supply chain. However, there are some fundamental differences between them. While the clothing industry can be considered as a labor-intensive industry, textile industry is more capital-intensive. In addition, in the textile industry companies are more heterogeneous and quite often highly specialized. The companies differ from each other by the size, used raw materials and production process. Especially special textile industry, including paper machine clothing, technical textiles, nonvowens, hygiene and hospital textiles, has been developing positively in Finland (Haimakainen *et al.,* 2000).

Christopher *et al.* (2004) separate four different kinds of characteristics of the fashion industry: (1) short lifecycles, (2) high volatility, (3) low predictability and (4) high impulse purchase. Firstly, short product lifecycles are caused by the fact that fashion products are normally designed to be ephemeral and seasonal. Secondly, demand of these products is rarely stable or linear, which causes high volatility. Demand can be influenced by different factors, like weather or perhaps a pop star. Thus, this high volatility and seasonality causes

low predictability of the demand. Finally, consumer's buying decision can be difficult to predict because of high impulse of purchasing. These characteristics set big challenges to logistics management. At the same time there is a growing tendency to source products and materials offshore, which in many cases has led to significantly longer lead times. Even though there can be a substantial cost advantage, the effect of the longer lead time can be severe, including increased risk for forecasting errors. The end result can be longer pipelines including rise inventory levels, as well as lost sales.

The Finnish textile and clothing industry have seen disappearance of jobs during last decades. Companies in the industry have been seeking different kind of options in order to survive in fierce competition. Especially, manufacturing of wearable apparels has been decreasing in the whole Europe and jobs have moved to low-cost sites, like China and India. The typical characteristics, like small enterprise size and extensive networks of suppliers, subcontractors and customers influence to the ways this industry can maintain its ability to compete. The future challenge of the textile and clothing industry will be diverse.

3.3 Future challenges

The textile and clothing industry can be considered as a mature industry, because machines, know-how and raw materials are available for everyone in the world. Along with the development of global economics, the European, and also the Finnish textile and clothing industry, have already faced several, challenges in order to attain and sustain competitive advantage. Also technological development and changes in consumer behavior set new kind of challenges for the industry. This section introduces the future challenges for the European, as well as for the Finnish textile and clothing industry. Firstly, this section introduces the general changes and challenges to the European textile and clothing industry. Secondly, this section presents also challenges that the industry in facing while applying information technology. In the end this section the challenges that product characteristics set to the companies are reviewed.

Euratex has followed several years the development of the textile and clothing industry and has actively worked for maintaining competitive advantage in the industry. Euratex (2002)

lists four kinds of challenges that will set new kind of demands for businesses within the European textile and clothing industry:

1. *Changes in international trade,*
2. *Changes in consumer demands and markets*
3. *Availability of human and intellectual resources*
4. *Development of technology*

Firstly, the end of restrains in the textile and apparel export, along with increasing globalization, will promote even more in the future the Chinese and Indian textile and clothing industry. Thus, the European textile and clothing companies will need to be more offensive in their search for new markets as well as maintaining the competitive advantage in the existing ones. This means that companies must be able to innovate and operate efficiently in the future.

Secondly, the changing consumer demand and markets will be challenging for the industry, while markets have been developing to more demanding direction and at the same time consumption in high-income countries is unlikely going to increase significantly. Many European companies have increased their operational integration and extended their activities vertically or horizontally by mergers, acquisitions or by subcontracting and therefore have become also importers or distributors, as they still are manufacturers. In these changing circumstances the future growth can be found also from technical and intelligent textiles, as well as high value functional, healthy, environmental friendly and personalized textile products. These changes require companies the ability to work with smaller batches, greater flexibility and ability to respond quickly.

Thirdly, companies in the textile and clothing industry will face challenges also in human and intellectual resources. The increasing complexity and acceleration of business set high demands for SME companies in the industry. Thus, enterprises are forced to develop and efficiently manage cooperation and network structures across the company boundaries. Because of these changes a clear enterprise strategy supported by appropriate structures and also extensive use of information and communication technology will be fundamental for succeeding in the future. In addition, the increasing vertical integration of companies will force companies to improve monitoring. A third area of competitiveness is importance of

brand management. Along with these also scarce resources of qualified, skilled, high-tech personnel will be big challenge to the companies.

Fourth challenges, technology, can be divided into two sub-factors: the innovation factor and the e-Factor. In the textile and clothing industry developing and innovating is a necessity in order to survive in increasing global competition. By the e-Factor, Euratex refers to necessity of investing and deploying information and communication technology. Ongoing concentration at both ends of the supply chains will be demanding for information systems. Different kind of information systems will have a big role in supply chain management in the future and can be challenging especially to SMEs in the industry. While the industry is still considered quite traditional, streamlining all the company functions including also repercussions on existing company structures and processes will be big challenge for many companies.

Parnell's (1999) division of future competitive resources supports quite well with previously introduced Euratex's view. He divides challenges in the textile and clothing sector into three categories based on operator. Firstly, retailers should be maintaining momentum and comparable store sales. Parnell sees that it is also important to build brand and through that growth will be possible. Secondly, apparel manufacturers should be focusing on capturing value. Brands are important also to apparel manufactures, but the key issue to their value equation is the ability to manage very extensive and complex sourcing networks. Thirdly, the consolidation of retail and apparel sectors will culminate to textile manufacturer, and they are forced to adapt the changing competition and business environment.

As the textile and clothing industry has grown and become more complex, the challenges for IT have grown with it. Firstly, more information is collected than ever before. Secondly, data is used for more and more complex analyses. Thirdly, less time is available to process data. In addition, information is being applied and shared more internally and externally with supply chain partners. Finally, constant changes in business environment set high demands and requires flexibility from IT application and databases. Current IT solutions are able to support more effectively integrated processes and thus rewards for investing IT can be worthy. New infrastructure supports information visibility, integration, and growth. Thus, through visibility and increased integration, companies can have better abilities to be more

responsive to customer demands. Also current IT solutions provide more accurate information as well as ease the information processing (Parnell, 1999).

According to Riikonen and Valkokari (2004, p. 61-62) the Finnish clothing industry is facing challenges in the use IT and how information systems are applied, while the amount of information is increasing, data management is significant factor in maintaining competitiveness and in defining the critical success factors. This supports Euratex's view about the importance of deploying IT together with efficient processes in gaining and maintaining competitiveness as well as Parnell's vision about the importance of the IT systems. It is important for companies to figure out what information is available, what information is wanted and what information can be applied. Information systems can provide possibilities to manage and acquire information efficiently, thus creating critical success factor in the clothing industry. With the help of effective information systems information available from customer behavior could be applied in steering the production network.

Christopher *et al.* (2004) suggest that answer to increased volatility and uncertainty cannot be managed only by developing more accurate forecasting methods. Especially, in time based marketing it's important to develop agile supply chains, which are market sensitive, virtual, network-based and process aligned. These features set high demands for internal processes, integration as well as adoption of information technology.

The European, as well as Finnish textile and clothing industry have been facing several challenges. Answering to these challenges the industry can maintain and develop its competitive ability. Firstly, challenges are related to markets and more demanding customers. In addition with increased global competition, European companies are forced to search competitive resources from different aspects. Information systems can provide many possibilities, but applying them right way can be challenging as well. In order to be responsive and be able to forecast the future demand, well-defined strategy supported with appropriate information systems and efficient business processes can be the key success factors.

3.4 Information Systems in the Textile and Apparel Industry

Information technology plays a major role in every industry and retailing nowadays, also in the textile and clothing industry. Surprisingly, Hakuli and Routamaa (1990) have proven already in the late 80's that in the Finnish clothing industry comprehensiveness of the use of IT seemed to be related to the success of the firms. Especially small enterprises benefit more from investing IT. This section introduces the information system taxonomy in the textile and clothing industry and systems applied and also reviews mainly ERP implementations in the industry.

Stellmach (2003) recognizes three different trends in information systems in the textile and clothing industry. Firstly, present-day systems offer extensive and highly developed continuity and functionality, providing efficient and flexible support to the textile companies. Secondly, the Internet, web browsers and e-mail are nowadays almost standard allowing global communication and cooperation, thus supporting new business models, e.g. e-business and extended enterprise. Thirdly, the spread of graphical, context sensitive, user interfaces has made systems easy to use and operate. In addition, the use of common relational databases is enabling the global information sharing. Customized implementations, configuration and integration of information systems are considered nowadays relatively simple. Especially global access and networking seem to be important to information systems applied within the textile and clothing industry. However, the diversity of the existing information systems integration on both an IT level and a business organization level is still ongoing progress.

The fast changes in fashion have driven companies in the textile and clothing industry to seek the efficiency from industry specific information systems. In the textile and clothing industry specific ERP systems are presumably more common than in the other industries. The industry is driven by sales and thus the cycle times are short, which have been said to be the most important reasons that the clothing and textile industry is implementing industry specific ERP systems. Also, a huge amount of product names and networked business environment have been listed as another reasons (Ihanus, 2005).

Hill (1998) recognized in the software survey that some industries, like the textile and clothing industry, have specific needs relating to their information systems. Different kind of supply chain structures inside the industry set high demands for all the information systems, including the ERP systems. Some companies are focusing in their operations to everything else but retailing and in addition there are some companies that operate within the whole supply chain, including apparel manufacturing and retailing.

Hodge (2000) outlined taxonomy of textile information systems including ERP system in the heart of the whole information system architecture (figure 3). However, in the textile and clothing industry ERP system has a strong connection to SCM system and Manufacturing Execution System. According to this interpretation Product Data Management (PDM) and Human Resource Management are excluded from ERP. However, nowadays in many cases PDM systems are integrated also to Manufacturing Execution Systems, like they are integrated with ERP systems.

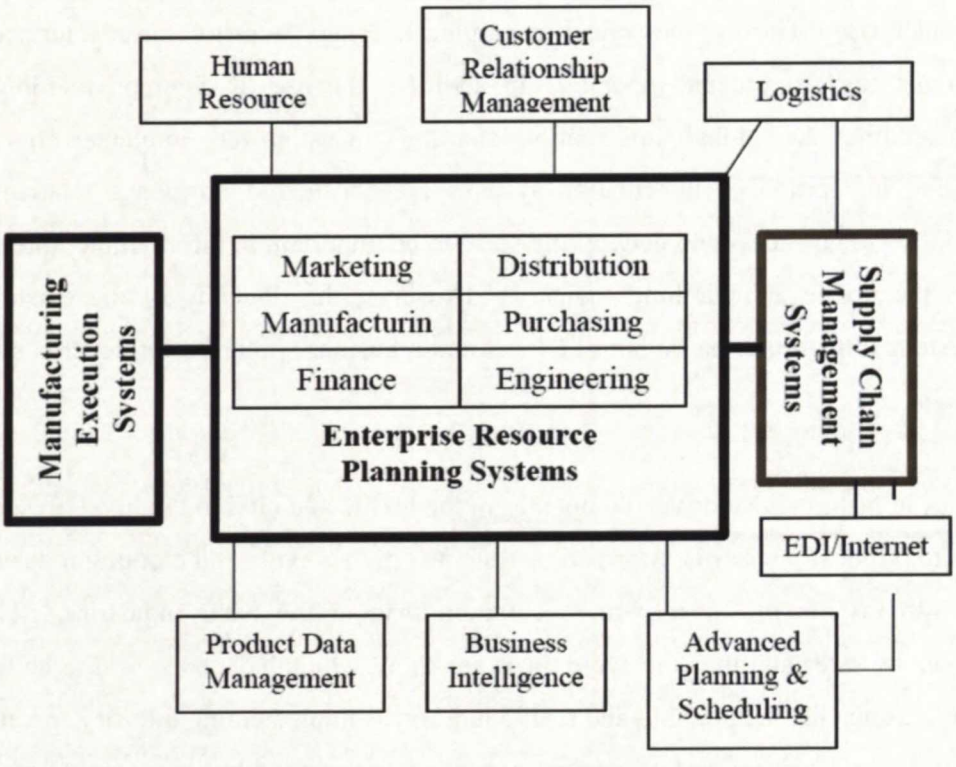


Figure 3. Taxonomy of Textile Information Systems (Hodge 2000)

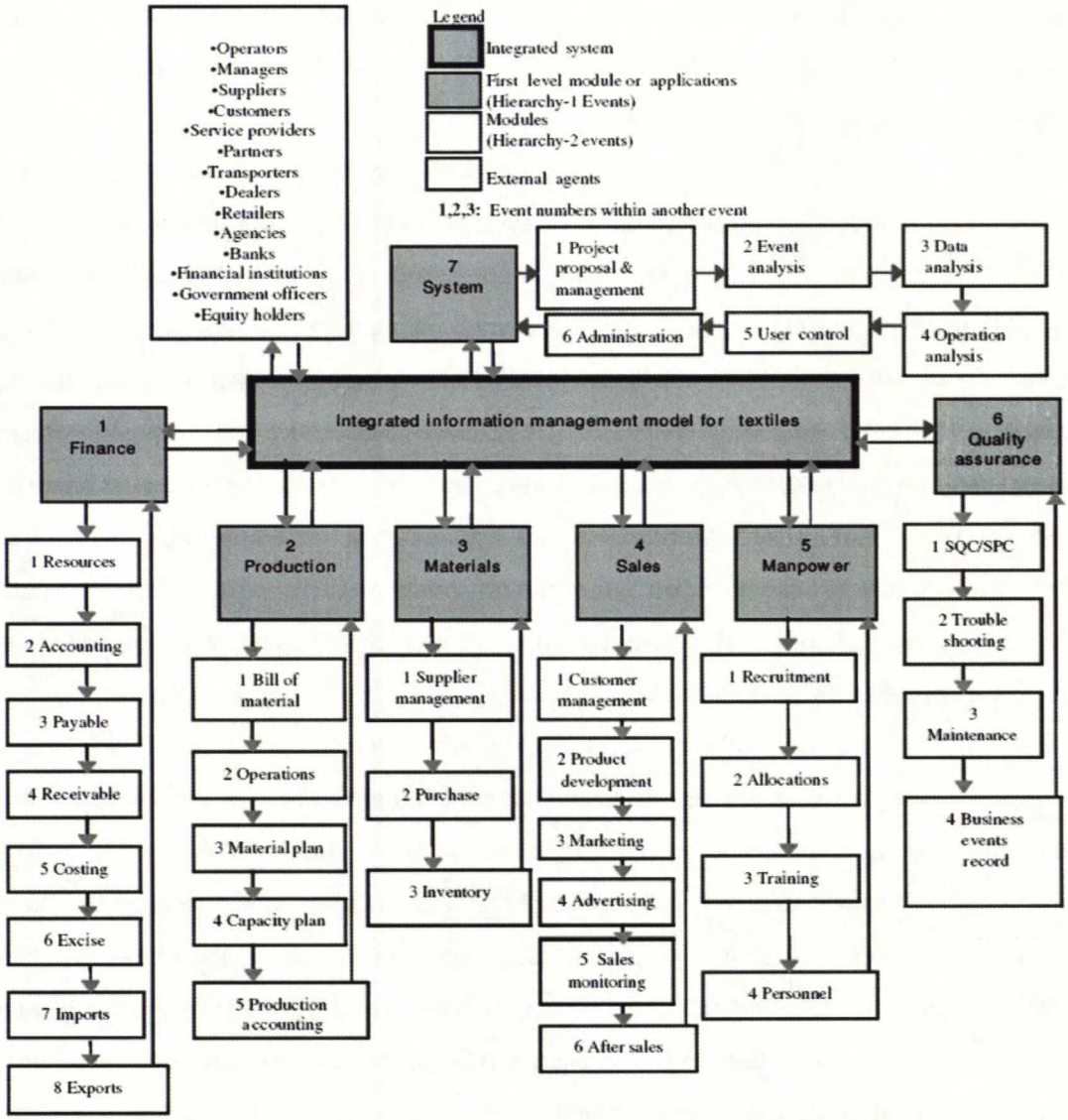


Figure 4. Integrated information management model for textiles (Chiplunkar *et al.*)

Chiplunkar *et al.* (2001) provide different kind of aspect to the textile information systems. They developed an integrated information management model for the textile industry, because they have noticed that during past decades many organizations have tried to implement different IT systems in order to improve co-ordination of information and therefore activities between different departments (figure 4). Chiplunkar *et al.* argue that many industries, including the textile industry, have find it difficult to implement ERP systems due to the amount of work involved, needs for customization and high reported costs during implementations. However, the structure of this model follows mainly the structure of many ERP solutions. The integration model focuses on integrated information management in order to improve effectiveness of production and streamlining it, but it also aims to provide

tools for business analysis. The integrated information management model is divided into seven modules: (1) finance, (2) production, (3) materials, (4) sales, (5) manpower, (6) quality assurance, and (7) system administration.

Hodge (2002) noticed that selecting the ERP system in the textile industry was influenced by following factors; fit of the software to the textile and apparel industry, costs, support and maintenance, flexibility and functionality. Also vendor stability, number of customers and a proven record in the textile sector were mentioned. This study also suggests that textile companies are looking to integrate their ERP systems with SCM. This study supported the earlier mentioned fact that software vendors keep developing solutions for specific industries. Surprisingly, according to Hodge it seems that implemented ERP solutions haven't provided internal integration expected: only 56% of the respondents identified that their implemented system provided full integration and almost a third of respondents were labeled as being integrated within business units.

Stellmach (2003) outlines also the fact that standard interfaces between systems and system integration are important issues in the textile and clothing industry. Wide use of CAD and CAM systems in product design and use of ERP systems can enable product development across process stages. According to Stellmach many current ERP providers offer systems with comprehensive functions for all commercial areas and cover the broad area of material and time management. Also widely used CAD and CAM systems can be nowadays integrated as a part of system infrastructure.

According to Parnell (1999) apparel manufacturers enterprise system or ERP systems should include many different functions, including *product development*, *merchandising*, *forecasting*, *planning*, *purchasing*, *sourcing*, *distribution*, *financials*, *human resources*, and *payroll*. Quite often these applications are separate ones with different hardware platforms and experiences with one ERP package installation are still rare in the industry. Parnell sees IT either as a disabler or enabler and with proper ERP solution both strategic advantage and competitive advantage could be achieved. Parnell lists few critical, yet quite general, advantages, which can be achieved by better-defined enterprise-wide solutions:

1. Architecture to support growth.
2. Minimized interfaces between older systems and platforms.

3. Less complex IT resource profile- no need for multiple hardware platforms, languages, databases, etc.
4. Reduced training costs.
5. Simplifications and minimization of overall maintenance and management of enterprise architecture.

Cole (2005) outlines that heightened competition, new business practices, globalization and multi-channel distribution models are some reasons confronting apparel retailers and manufacturers to squeeze more functionality from their information system, like ERP and supply chain solutions. The emphasis has been recently in data synchronization, while the premises of applications have improved. In addition with optimizing physical supply chain, companies should consider more also financial supply chains. Thus, optimizing financial transactions related to paying duties and tariffs and extensions of credit between large retailers and their oversea vendors could mean achieving new kind of efficiency in supply chain.

Apparel –magazine listed 170 international and American information system vendors for the textile and clothing industry in their Software Guide (www.apparelmag.com). The guide included information about the vendors, including e.g. number of international and American customers, years in business, reference clients, program names offered, primary type of offered systems, operating systems, and database engines. The Software Guide presents vendors from all the main application areas: ERP, BI, CAD/CAM, PLM, SCM, POS terminal systems, CRM and PDM, but also other industry specific applications like color management softwares, embroidery digitizing, and apparel planning were introduced. 47 of 170 vendors provided mainly ERP solutions, but offered also different kind of solutions for supply chain collaboration and material inventory control. According to Software Guide biggest ERP vendors (>3000 customers worldwide) were AIMS, Alpha Retail Technology Inc, Microsoft Corporation, and Pebblestone Inc. Biggest software portfolio offered, including ERP, supply chain collaboration, automated financial transaction processing, forecasting, EDI, POS data collection and material inventory control and management, cut order, MRP II, fabric allocation provided e.g. Intentia Americas, SAP, and Pebblestone Inc.

According to Hodge (2002) several different ERP systems are applied in the textile and clothing industry. Applications that were mentioned in the study were ACS Optima, Baan, BPCS, Datatex, Intentia MovexFashion, JD Edwards, PointMan, SAP, and SyteFashion. In

this study Datatex was most frequently listed package, which can be considered as an industry specific ERP. Three out of twenty-five had developed systems in-house or were applying best-of-breed approach by combining modules from different vendors. ERP applications had also several linkages to other applications, including advanced planning and scheduling (APS), business intelligence (BI), Financial and Accounting, Manufacturing Execution Systems, CRM and SCM.

The textile and clothing ERP markets can be characterized by two factors: industry specificity and geographical focus. Some ERP system suppliers provide generic systems, while others have focused to some specific industries. Hodge (2002) suggests in his research that both generic and textile specific packages have been utilized in the industry. According to Stellmach (2003) textile ERP suppliers are focusing either global markets, like Datatex (Switzerland) or local markets, like Dafo in Finland. Many ERP suppliers offer also special integration services between different applications. In addition, to some generic ERP solutions, like Microsoft's Navision, industry specific modules or functionalities can be included in order to increase the applicability in the textile and clothing industry.

One of the biggest ERP vendors, SAP AG, released 1998 SAP Apparel and Footwear application (SAP AFS), which was reported in several medias (e.g. Computerworld, 2000; Apparel Industry Magazine, 1998). The application was developed in conjunction with its biggest customers, Reebok International and VF Corporation, from the textile and clothing industry. These customers helped SAP AG to develop solution, which fulfill the multiple dimension requirements of apparel manufacturers. However, during the development and implementations problems with bugs and missing functionalities were reported and SAP formed a special team to fix these problems after several customers cancelled their projects during 1999. Later several successful projects in the industry were reported, including implementations of Italian Benetton, Adidas –Salomon, and Levi Strauss Corporation.

According to Software Guide SAP AFS total amount of implementation in the industry exceeds 125 worldwide. SAP's application range covers following areas:

- Strategic planning
- New product development and introduction
- Integrated supply chain planning (incl. demand and supply planning, responsive replenishments, production planning and detailed scheduling)

- Sourcing and procurement (incl. strategic purchasing and procure to pay)
- Sales and marketing (incl. order-to- cash, brand management, account management, sales force management)
- Demand fulfillment and execution (incl. manufacturing, inbound and outbound logistics)
- Enterprise management and support (incl. analytics, financials, human capital management, corporate services, operations support)

Because SAP AFS ERP solution doesn't cover all these areas, separate SCM functionalities can be implemented, e.g. in integrated supply chain planning, sourcing and procurement functionalities. Also for the extended customer and supplier relationship management separate applications can be included to implementation

Microsoft Business Solution has developed industry specific functionalities for the textile, clothing and shoe industry to their Navision ERP system. The application is called NaviVariant and the operational focus is in managing product variety, which is probably the most challenging part in implementing a generic ERP solution in the textile and clothing industry. The emphasis has been e.g. developing order management functionalities, possibility to maintain unlimited variety of different sizes and colors, improved ability to use EAN-coding, reporting and ability to create interfaces to external information systems, e.g. retailers, subcontractors and central corporations. According to system vendor (www.microsoft.com) NaviVariant improves efficiency of purchasing, inventory management, season and collection management, inbound and outbound logistics, customer and supplier relationship management and financial processes.

Finnish Dafo ERP is applied widely in the textile, clothing, shoe and bag industry. In Finland Dafo is a market leader with almost 200 customers (Ihanus, 2005). The application can be used widely in manufacturing, apparel importing, retailing and subcontracting and with multiple languages also global use is possible. Dafo's key functionalities are focused in production management, order management, but it can include modules for warehousing, invoicing, reporting (table 8). Financial applications are excluded from Dafo, but there are more than ten separate applications that can be integrated with it. Dafo can be also integrated with other applications or systems, including Manufacturing Execution Systems (cutting system and CAD), different PDM systems, POS- payment terminals, EDI/ XML, Financial Management, Internet, external warehousing systems, bar-coding and labeling systems,

standard time systems, and e-letters. By using Web Dafo- application suppliers, customers and own stores can connect straight to the company's ERP systems.

Table 8. DAFO's modules and functionalities

Module	Functionalities
Order management	Order maintenance, print and enquire orders, order reports, product status (considers inventory levels, future production plans or procurements, sales), order statistics, material demand based on orders.
Product Management	Maintaining of product codes, sizes and colours. Can be integrated with PDM applications (Gerber's WebPDM, teamCenter)
Production Planning	Maintaining work orders, maintaining cutting orders based on work orders, work orders for subcontracted production, work order reports, production control reports, work efficiency reporting. Can be integrated with cutter and its software, for example Gerber and Lectra.
Purchasing	Inputting, maintaining and printing purchase orders, reporting
Warehousing	Maintaining product inventory, inventory follow-up and reporting (including number of products sold, how much is coming from production, how much is planned, how much is free on stock, free on production and free on planned). Can be integrated with point of sales payment terminals.
Manufacturing budgeting	Connected with production planning, material management and purchasing.
Material Management	Maintaining material information, material enquiries, material reports, material ordering, maintaining material warehouse
Outsourcing/ Subcontracting	See production planning and purchasing
Invoicing	Maintaining invoices, printing invoices (also electronically), Invoice reports, transferring to sales ledger, export invoicing (including: group invoicing, bills of entry, customs declaration), material invoices
Dispatching	Collecting report, maintaining delivery notes, maintaining request of sending, maintaining freight of bills,
Reporting	Ad Hoc reporting, structured reports

While many of companies, who have implemented Dafo, are quite small, system supplier, WM Data, has developed SCM, APS, outsourcing, and forecasting functionalities to Dafo. For example tracking subcontractors' and suppliers' workload is possible in order to ease the planning of production. However, WM Data has been planning also to build more integration

interfaces to SCM applications, because the importance of outsourcing and forecasting is increasing all the time. While many of manufacturers have established their own retailing network and vertical integration in the idnustry is increasing all the time, also chain control functionalities have been developed to Dafo. Therefore the system can be integrated with some POS payment terminal systems.

Information systems play nowadays important role also in the textile and clothing industry. In addition with PDM and CAD/CAM systems, ERP systems have become important part of information system architecture in the industry. Industry specific ERP solutions have been developed during last decade and many enterprises in the industry have been forced to implement one in order to respond to increased need for information and integration. Seamless information flow and business processes between enterprise functions and supply chain members have been objective for many ERP implementations in the textile and clothing industry.

3.5 ERP Implementations in the Finnish Textile and Clothing Industry

Several ERP implementations in the textile and clothing industry have been reported in several medias lately, including company web pages, trade magazines and press releases (e.g. Ihanus 2005; www.sap.com; www.microsoft.com). Common for these implementations have been urge to seek competitive advantage by making key operations more efficient. Thus, reasons mainly for these implementations have been focusing improving order and material management, instead of e.g. financial management. Due to heterogeneity of the industry also different kinds of applications have been implemented. The textile industry chooses mainly systems that support process oriented production, like Tamfelt Oyj, but also industry specific ERP systems have been implemented. The clothing industry has traditionally chosen industry specific ERP solutions, because of the large variety of product dimensions (colors, sizes etc.). These systems have quite often focused on production planning and material management. Also in-house developed systems are applied in the clothing industry (e.g. L-Fashion Group, Naisten Pukutehdas and Finnkarelia).

SAP AFS has focused on multibillion, global companies in the industry and thus there is only one Finnish textile company who has implemented SAP's ERP system, Tamfelt Oyj, manufacturer of paper machine clothing and technical textiles. Tamfelt has production facilities in Finland, in Portugal, in Brazil and in China. The company has implemented SAP ERP for Mill Products, which is targeted business segments like furniture manufacturing, forest products and paper, but also to the textile industry. SAP Mills replaced the old legacy system in Tamfelt. According to the company the biggest challenge for the implementation was to find right way to apply ERP solution in own production, because every product is tailor-made and produced according to customer specifications. The main business objective of the implementation was to develop material management. At the moment Tamfelt is applying SAP in financial, sales, production, quality management, plant maintenance, material management and procurement (www.sap.com).

Microsoft Business Solutions has developed to its Navision ERP system also industry specific functionalities for the textile, clothing and footwear industry called NaviVariant. A Finnish clothing company, Reima Group, have implemented Navision ERP in their three divisions: Reima Oy, Tutta Oy and Clothing Plus Oy. There were two main reasons for implementation. First of all, the old tailor-made legacy system has become to end of its lifecycle. Secondly, the company has changed during last decade so dramatically that the old applications were not able to serve the current corporate business model. Moreover, also the changes in the industry, like increased procurement and outsourced production as well decreased of own in-house production, were also considered as change drivers in acquiring a new ERP system. The rollout started in summer 2005 and during spring 2006 all three divisions will be using new ERP application. During the implementation company's financial management was outsourced. Reima Group emphasizes that one of the most important improvement concerned the ordering process. According to press release internal integration achieved by new application helps the company to automate its own internal processes (www.microsoft.com).

Finnish Nanso reported their Dafo ERP implementation during year 2005 (Ihanus, 2005). The company is manufacturing wearable apparel in different product categories, including underwear, night wear and clothing for men, women and children. Products are marketed in Finland, in Sweden and in Germany under three different trademarks: Finnwear, Nanso and Blackhorse. The company has five production facilities: in Nokia, in Parkano, in Tampere, in Parola, and in Tallinn (www.nanso.com). In Nokia facility products are manufactured from

yarn, which means that the company knits its own fabrics. The whole production process utilizes information technology and all the applications and systems are linked to the company ERP system. In the beginning of the process fabric and product designs are made by using design software called Prima Vision. The knitting and dyeing processes are automated and quality controlled tightly with the help of information technology. Patterns are made by special software as well as cutting plans in order to optimize the use of the materials. In Nanso Group's implementation their production process set high challenges, while the beginning of the process, knitting and dying, reminds process industry, and in the end of process, cutting, sewing and finishing, reminds single product production. The key drivers for the ERP implementation have been changing customer-demands, decreasing share of up-front orders and the possibilities information technology offers.

One of the Scandinavian biggest apparel manufacturers is L-Fashion Group. The company is offering big variety of wearable apparels from jeans and outdoor clothing until evening gowns and shoes, bags and accessories. Best-known trademarks of the company are Rukka, Skila, Luhta, Torstai, IcePeak, Ril's, and Beavers. L-Fashion Group has also own retail chain, called Aleksi 13. The company is using tailor-made, in-house developed ERP system. The system is applied in product design, during production and also in retailing. Also the logistic service providers have integrated their system to L-Fashion Group's ERP. In addition, with few of the biggest European retailers detailed information can be exchanged between information systems. The ERP system has been developed actively during the last years and the focus areas in the development have been in user-friendliness, the changes in business environment and improved process automation (Ihanus, 2005).

Most of the reported ERP implementations in the textile and clothing industry have few common factors: companies are aiming to response changes in the business environment, replacing old legacy systems and seeking competitive edge by updating their information systems. However, many companies in the industry have seen industry specific or in-house developed systems as only option and the possibility of generic ERP solution have not been considered. The essential theme in these implementation projects have been also improved SCM.

3.6 Supply Chain Management in the Textile and Clothing Industry

Product characteristics and industry structure can influence to the structure of supply chain and therefore this section introduces key issues in SCM in the textile and clothing industry. The supply chain structure and strategies can vary a lot depending on several factors, like product characteristics, maturity of the industry and number of parties involved. Fisher (1997) introduces different kind of supply chain strategies in order to show the connection between product characteristics and the right kind of strategic alignment of SCM. Fine (2000) supports the same idea by introducing double helix model by using vertical/integral and horizontal/modular division with products and industries. In the textile and clothing industry supply chains can be considered complex. Often the quite long supply chain involves a large number of different parties. It is quite common that retailers deal with manufacturers with centralized buying functions and have the power in negations about price, quality and delivery schedules (Bruce and Moger, 1999).

According to Parnell (1999) typical scope of SCM in the textile and clothing industry includes product development, demand management, planning, manufacturing scheduling, procurement, order management and distribution. Targeted benefits can be diverse, including issues like reduced inventory, improved customer service, reduced supply chain cycle times, decreased obsolete inventory, and increased asset utilization. In order to achieve these benefits several issues should be considered, including level of detail, visibility of supply and demand, inventory management, planning consideration and integration.

Model about the global apparel supply chain reinforces the connection between the textile and clothing industry as well as the firm connection with retailing (figure 5). When a material flow goes from fibre, yarn and fabric production all the way until store, information flow is normal backwards. Traditionally, fabric manufacturers design their own collections; garment manufacturer selects some interesting fabrics and designs their products from those fabrics and finally, retailer choose garments they want to display in their collection and stores. Forecasting done in the end of supply chain can be difficult and the information flow all the way to the beginning of material flow isn't always causing the desired outcome. In some cases the whole supply chain ends up doing three different forecasts for the season (Mattila, 1999, p. 33).

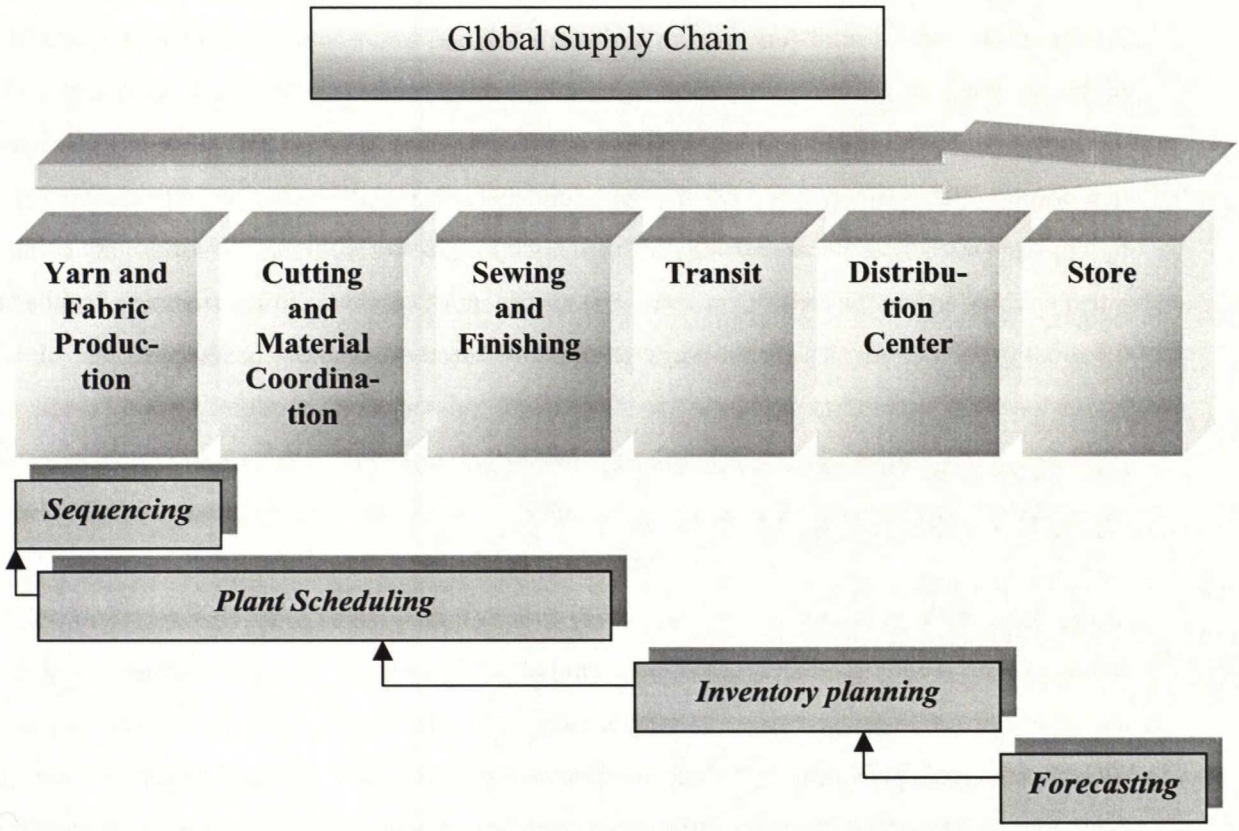


Figure 5. Apparel supply chain (Abend, 1998; modified Mattila, 1998)

Several studies have been conducted in the textile and apparel industry in order to compare different kind of supply chain strategies within the industry (e.g. Fisher and Raman, 1997; King and Hunter, 1997; Mattila, 1999; Bruce *et al.,* 2004; Christopher *et al.,* 2004). These studies have showed the importance of supply chains agility and organization's ability to react to changes in demand. Especially the focus in these studies has been minimizing the forecast error, which can cause missed sales opportunities through stockouts and markdowns as well as high unsold inventory levels. Agile supply chain and quick response (QR) concepts have been explored and reviewed in order to minimize forecast errors, which tend to increase along a lead-time. Fisher and Raman (1997) showed that forecasts based on actual sales minimized forecast error. Bruce *et al.* (2004) compared agile and lean supply paradigms within the UK textile and clothing industry. Surprisingly, they discovered that in order to achieve best possible result with the low margins and volatility of demand, companies within the industry must apply and combine both lean and agile perspectives.

Mattila (1999) compared three different apparel sourcing strategies: traditional, quick response (QR) and vendor-managed inventory (VMI). In traditional sourcing strategy focuses on minimizing costs and the goods are purchased from least expensive supplier. This normally means offshore sourcing with one delivery prior to season. OR sourcing strategy is based on mixture of up-front buying and replenishments during the selling season. The replenishments are done according to POS information. In VMI some goods are shipped advanced based on buyer's plan and replenishments are done from stock and no POS information is shared. These products are manufactured beforehand based on forecasts and warehoused by manufacturer. In his study four most critical success factors in apparel retailing are *forecast accuracy*, *process lead-time*, *up-front/ replenishment buying mix* and *off-shore/ local sourcing mix*. According to Mattila QR seemed to be best strategy for retailers.

Mattila's study was based on previous study conducted by King and Hunter (1997), which founded similar implications. In order to applying QR strategy requires product bar coding and sharing of POS information. This approach is similar with Efficient Consumer Response (ECR), which is also aiming to reduce inventories, while QR is focusing to ensure the customer satisfaction with the right collection of merchandise. ECR is emphasizing three features: customer focus, partnership development and integration of activities. The objectives of this ECR strategy are archived by efficient category management, product replenishments and enabling technologies (Lamey, 1996).

In SCM the focus has been minimizing the forecast error, while it may cause severe losses. The key issue that was found in several studies (e.g. King and Hunter, 1997; Fisher and Raman, 1997; Mattila, 1999, Christopher *et al.* 2004) was that companies should be able to maintain supply chain agility and ability to respond to changing customer demands in order to achieve best possible result. Information sharing and effective SCM are necessities in even demanding markets.

4. Research Methodology

This chapter introduces the research methodology applied in this study. First, theoretical background of qualitative approach and case study are introduced. Second, progress of this study is introduced following seven stages of case study. Finally, the execution of four pilot case studies and case study of MASI Company are presented.

While both previous ERP and SCM research have strongly focused on studying practices applied in companies, it was obvious in selecting the research method for this study that research will be based on qualitative analysis. In addition, especially SCM is considered in some cases quite confidential because its strategic importance and thus the aim is to get a deeper insight for the subject. According to preliminary interviews and the researcher's own experience, case study would be most beneficial from different qualitative methods.

Kasanen *et al.* (1991) have divided research paradigms in business management research into five categories: conceptual, nomothetical, action-oriented, constructive, and decision-oriented approaches (figure 6). Olkkonen (1993) sets case studies into Action- oriented approach in which combines theoretical, historical and practical information. In case studies problem is reviewed strongly from empirical standpoint and approach to research problem is both descriptive and normative.

	Theoretical	**Empirical**
Descriptive	Conceptual research paradigm	Nomothetical research paradigm
		Functions analysis research paradigm
Normative	Conclusive methodology research paradigm	Constructive research paradigm

Figure 6. Research paradigms in business management research (Kasanen *et al.* 1991)

Yin (1984) defines case study following way: it investigates a contemporary phenomenon within its real-life context. Case study is used especially when the boundaries between phenomenon and context are not clearly evident and it normally applies multiple sources of evidence. Case studies can be divided two ways: the number of cases and the objective of the study. Case study can be single- case study or multiple-case study. Case study's approach can be exploratory, descriptive or explorative. Case study can be divided into seven stages (modified from Eisenhart, 1989 and Yin, 1989):

1. Determine and define the research questions
2. Screening and select the cases
3. Determine data gathering and analysis techniques
4. Prepare to collect the data
5. Collect data in the field
6. Evaluate and analyze the data
7. Prepare the report

In the first stage the research questions and therefore also objectives were determined, which are described in section 1.2. Screening and selection of case started with collecting different kind of material of ERP implementation and information system development in the textile and clothing industry. First, pilot interviews were conducted with three Finnish companies in the industry were conducted: MASI Company Oy, Everdeal Oy and Naisten Pukutehdas Oy. The goal of these interviews was to gather some preliminary information about ERP implementations and use of the IT applications as well as different supply chain strategies. Appendix A includes the interview questionnaire. In addition, also secondary material was collected, including trade magazine articles, journal articles, companies' website information, press releases and company reports. Secondly, information about different ERP vendors, industry specific ERP solutions and generic ERP solutions with industry specific functionalities was collected. In this second phase also one Finnish industry specific ERP system called Dafo was reviewed and its vendor, WM Data, was interviewed. The questions asked in the interview are introduced in Appendix 2. The interviews lasted approximately from one and half hours to two hours. Thirdly, during this screening stage also international companies from the textile and clothing industry were investigated, American VF Corporation and Spanish Zara. Information about Everdeal, Naisten Pukutehdas, VF Corporation and Zara were integrated to form four pilot case studies. These case studies were applied in

determining data collection and analyzing techniques and in addition to recognizing key business processes for the evaluation framework.

This study combines single- and multiple-case study methods, while pilot case studies are used for creating evaluation framework and benchmarking the MASI Company case. The case study approach can be considered explanatory. According to information gained during the preliminary interviews MASI Company was chosen for more detailed analysis. In this analysis evaluation framework of this study (figure 8) was applied. The preliminary interview notes, transcripts and secondary material were used both during the preparation of data collecting as well as integrating the final case. In addition, MASI provided some additional material, including two masters' thesis concerning development of their production management and ERP implementation process. Finally, all data was evaluated and analyzed in order to integrate the final case study. Finally, different practices from pilot cases and MASI were benchmarked. The evaluation framework played essential role in the final case analysis.

5. Empirical Findings

This chapter introduces findings of the empirical research. First, the information gained in the case screening and selection phase is introduced in section 5.1, which introduces four pilot case studies. Section 5.1 introduces four pilot cases: two international and two Finnish companies, their use of information technology in the industry in order to develop supply chain practices. The pilot case companies presented in this part are VF Corporation and Spanish Zara, Naisten Pukutehdas Oy and Everdeal Oy. The, section 5.2 present the evaluation framework created in this study based on previous studies and literature about ERP and SCM and the pilot case studies. Finally, section 5.3 presents case of MASI Company. These pilot case studies have been important part in planning and designing the final case study of MASI Company. Pilot cases and case MASI are executed in following way: first, all the necessary background information are presented. Then, the company's ERP solution is described. Thirdly, the company's supply chain management is introduced including the supply chain structure. Fourthly, integration within supply chain and between business processes is reviewed. The analysis is based on the evaluation framework.

5.1 Pilot Case Studies

This section reviews four pilot case studies. The pilot case studies include four different cases, in which different data collecting methods and key issues for evaluation framework were explored. Aim of these pilot case studies have been finding out how companies can apply information technology from different aspects and attain competitive advantage from it and thus time develop their operational efficiency. The main objective for all of these companies has been developing supply chain to more responsive direction. First, VF Corporation is introduced, which has implemented several package softwares and been able to make most of them by improving efficiency of key business processes and increasing responsiveness of the supply chain. Secondly, Spanish Zara is introduced, while their approach to applying IT differs from its biggest competitors. It is applying different kind of supply strategy, and uses mainly in-house developed IT applications in supporting the business processes. Third pilot case company in this study is Naisten Pukutehdas Oy, which applies in-house developed ERP system in all the operations and is also developing the system further. Fourth pilot case is Everdeal Oy, which has implemented their industry

specific ERP system already in 1994 and is at the moment expanding fiercely to retailing sector as well. Both Finnish pilot case companies are subcontracting their production offshore and have chosen to their competitive strategy efficient, responsive supply chain in addition with brand management.

5.1.1 VF Corporation

Over 100 year old, VF Corporation is one of the world's largest apparel companies. The product range is divided into five coalitions: jeanswear, intimate apparel, outdoor, sportswear, and imagewear, and thus VF Corporation is considered one of the most diversified apparel companies in the world. The biggest coalition is jeanswear and according to the company's annual report 2004 it sells more pair of jeans than any other company in the world. Different brands reach consumers in nearly every channel of distribution. Even though VF Corporation has altogether 52 different brands, probably the most well known trademarks of the company are Wrangler, Lee, NorthFace, and EastPak. In year 2004 annual turnover exceeded $6 billion and corporation's operating margin rose up till 12.8%. Even though the focus is in U.S markets, almost quarter from its sales comes from international markets from 150 different countries. The company has been growing during last years due to acquisitions and by increasing sales by matching supply to customer demand (www.vfc.com).

Among retailers VF Corporation is known for its willingness to be innovative and that they have the necessary IT capabilities to support operations. VF has been building its replenishment systems from the beginning of 90's (Bachelodor, 2003). The system was based on Data Warehouse (DW) and it was called Market Response System. At that time this system provided strategic advantage to the company. Consequently, the replenishment process is quite complex and problematic and the system has been developed further during years. By using EDI connection POS information captured is transmitted from several retailing point. The inventory and sales information were analyzed carefully and fed into a complex set of replenishment models. These models suggested which products should be sent from inventories and then the system suggests producing work orders for the remainder. The model also suggested changes to the stock mix or retail space layout, if needed. Turnaround times for restocking many of the company's products were reduced from 90 days to one week (Nemati and Hamid, 2000; Terry, 2005)

During last decades VF Corporation has invested a lot of money to develop information systems that would support their business processes efficiently. VF Corporation has implemented a big variety of different applications, including softwares from JDA Software Group, Spectra Marketing, i2 Technology Inc, and SAP (table 9). In addition the company is applying in-house developed Retail Floor Space Management. The ultimate goal for developing a new platform from different vendors was to integrate together several SAP components with in-house developed software and best -of –breed supply chain applications. The biggest challenge in the whole IT system renewal has been in moving from multiple legacy systems across its five coalitions to a common systems architecture using package softwares. Estimated amount of IT costs is over the industry average, 2.3% sales. However, the softwares are integrated tightly with each other and that way forecasts produced at store level can be rolled up to a system that helps the company to plan its production (Terry, 2005).

Table 9. Some of the IT systems used in VF Corporations and their functionalities

Application	Functionalities
SAP AFS (SAP AG)	ERP, including financial operations, order management, material management, sales, distribution
i2 (i2 Technology Inc)	Supply Chain Planning
e-SPS (New Generation Computing Inc)	Global sourcing
Trade Collaborator (NextLinx Corp.)	International trade
BRIO	Query Tools
SAS	Data Mining
Gerber WebPMD	Product Data Management
Logility	Demand forecasting

The core of VF's information system architecture is their ERP solution from SAP. VF Corporation was actively developing the SAP's apparel and footwear oriented platforms (SAP AFS) in cooperation with SAP AG and Reebok and was able to take part of the setting the industry standards for SAP industry specific solution. SAP AFS is applied widely in the company, including financial operations, order and material management and nowadays also in sales and distribution (Bachelodor, 2003; Terry, 2005).

Today VF's supply chain covers the whole world. It has own production facilities in United States, Mexico, Costa Rica and Honduras as well as contracts with third-party manufacturers in Asia, Africa, Central America, and Mexico. In the beginning of 2001, VF closed 30 factories in North America, shifting much of its production to third parties overseas. Today, approximately 95% of VF products sold in U.S. markets are sourced offshore from third-party subcontractors and VF-owned plants in Mexico and Central America. VF is buying far fewer raw materials and substantially more finished garments and products. VF has a sourcing office in Asia to oversee partner factories and also sourcing in Mexican and Central America is coordinated (Terry, 2005).

Product lead-times depend a lot upon where they are manufactured. For some of its plants in Mexico and Central America, VF sources raw materials, cuts, sews, launders and finishes garments on site and then ships them to distribution center in the U.S. However, there are myriad variations on this model; some materials are sourced and cut in U.S. and then sent for sewing in Mexico. After that they are sent back to U.S. where they are laundered. Lead-time for these is normally three weeks. If the jeans are made totally in U.S and are unwashed, lead-time can be short as one week. VF still continues to seek right balance between Asian and Central American production (Terry, 2005).

In supply-chain planning activities VF Corporation applies i2 Supply Chain Planner software and 90% of VF's domestic supply chain operations are planned with this application. After product designs phase, i2 constrained-based supply chain planning tool recommends sourcing strategies by taking into account safety stock requirements to deal with forecast error. This application takes account inventory policies, for example if the garment is less seasonal and less fashionable, it can be produced earlier and carry inventory. That way also longer delivery times from Asia can be considered in production planning. Interfaces between i2 and other applications have been built by VF's own IT personnel.

Offshore production is quite challenging, not only because of longer lead times, but also controlling subcontracting. In addition, increasing the level of cooperation with subcontractors, VF has implemented a special Internet based supply chain application for tracking offshore production, called e-SPS (Sourcing and Production System) from New Generation Computing Inc. This e-SPS software alerts VF when a contract manufacturer fails to meet a deadline and that way the company can react by delivering missed products from

somewhere else. E-SPS requires only PC and it doesn't require any sophisticated business technology. For easing the passage of goods through customs VF has implemented Trade Collaborator software from NextLinx Corporation. The Trade Collaborator software prepares documents for required in cross-border shipments and that way decreases costs (Bachelodor, 2003).

The biggest challenge for VF has been developing supply chain after several acquisitions. In addition it has been able to apply different kind of commercial information systems. VF has developed business processes with several different kinds of applications always starting form data mining and analyzing POS information to supply chain planning and optimizing (table 9). Most importantly, VF Corporation has been able to make most of its size. Big IT investments have been profitable because of the large scale of use. At the moment the company is developing ways to apply RFID technology in their distribution center (Terry, 2005).

5.1.2 Zara

Zara is a part of Inditex group, which was established already in the 1960's in La Coruña, Spain by Amancio Ortega. First Zara store was opened in 1975. In the beginning of the year 2005 the total amount of the stores was 723. The Zara chain's annual turnover 2004 was 3.8 billion Euros representing 67.4% of the group's turnover. 65.8% sales of the Zara chain come from international stores. In year 2004 the Inditex group's net income margin was 11.1% (www.inditex.com). During typical season Zara introduces 11 000 new garments. Zara's total lead-time for a new garment from conception to volume delivery into stores can be short as three weeks (McAfee, 2004).

Like its biggest competitors, Benetton, Gap, and H&M, Zara offers a large new collection at the start of each selling season. However, in Zara these designs are considered as a starting point, while throughout the season it constantly modifies garments and in addition introduces also entirely new ones. Decisions about producing certain garments are done according to sales information from all over the world. Design teams translate these customer desires into patterns of garments, which are then manufactured either in own factories or subcontracted. Finished garments are then sent to distribution center and shipped to stores all over the world. If some garments aren't selling in one store, they can be delivered to another store where it

could be selling much better (McAffee, 2004). Unlike its biggest competitors, Zara doesn't advertise practically at all. While, the company is spending so little to advertising, it spends heavily on its stores. The location is thought carefully and only best places in the major cities are selected (Ferdows *et al.* 2004).

Supply chain management is a central part in all the stages: design, production, distribution and retailing of clothes. Zara designs all its products itself. Designing is normally done in teams, which includes designers, market specialist and buyers. During the designing process cooperation within the team as well as stores are important in order to design right kind of products. The buyers' responsibility in the designing team is to manage procurement and production, monitor warehouse inventories, allocate production to various factories and to third party suppliers as well as keep track shortages and oversupplies (Ferdows *et al.* 2004).

Zara produces in-house a larger share of its sale than its biggest competitors. 50% of its products are manufactured in own facilities. Approximately 70% of subcontracted production is produced in Europe, rest in Asia. Many of suppliers are in Spain and in Portugal enabling quick response to customer demand. Also big part (40%) of the fabrics used in production is procured from Inditex owned subsidiary. Like Benetton, Zara applies also postponement strategy to gain more speed and flexibility by purchasing more than half of these fabrics undyed, which allows them reacting to mid-season color changes. Zara has also part ownership and close cooperation with dyestuff producer for the same reason. Complicated products, like detailed women's suites, are normally made in-house, while simple, basic products can be totally outsourced. Zara has over twenty production facilities, mainly in La Coruña area, two in Barcelona, one in Lithuania and few joint ventures in other countries. Even though cutting is made in-house for garments, Zara uses subcontracting for all sewing operations. Normally these subcontractors are small workshops with only a few dozen employees, and Zara is their primary customer. Subcontractors deliver ready-made products to Zara, where inspection, labeling and packing are done. During the whole production process products are labeled with bar codes for easing the follow-up during the process (Ferdows *et al.* 2004).

Zara's distribution center (DC) is in La Coruña and stores in Europe receive their orders in 24 hours, U.S. stores in 48 hours and Japanese stores in 48 to 72 hours. This distribution center delivers approximately 2.5 million items per week. Automation of distribution center has

been the most significant investments in information technology. This logistics center contains over 200 kilometers of moving rails, and automated routing systems, which delivers electronically tagged garments to the appropriate loading bays for distribution. Products are ready for dispatch after eight hours they have arrived to distribution center. In year 2003 opened a new logistic center in Zaragoza, Spain. Garments are delivered by airfreight twice per week all over the world. Garments are normally shipped on hangers and labeled with bar coded price tags (Ferdows *et al.* 2004; Fernie, 2004).

Even though, store managers can decide the collection in the store, the interior of the store and layout is decided in the head office and all the stores look alike. Also garment price setting is centrally coordinated. Ordering process is also standardized. Every store sends headquarters detailed orders twice a week. The systems in-store doesn't track local inventory and thus store personnel isn't able to see their own inventory balances while preparing the order. The POS terminals in Zara stores are not connected to one another or to headquarters. Zara stores use dial-up modems to send daily sales total and twice-weekly orders. Similarly, there is no private exchange or extranet covering the supply chain of factories, subcontractors and distribution centers. At the company headquarters computers run only internally developed applications, while Inditex doesn't apply any commercially available enterprise softwares (McAffee, 2004).

Despite of lack of big commercial IT applications, important focus area already from the beginning has been the effective use of information technology. Inditex's experience has shown that it is possible to masterfully select, adopt and leverage IT while spending very little on it (0.5% of revenue). Surprisingly, even though Zara runs an information-intensive business, it applies remarkably little information technology. All the applications needed are written by themselves rather than buying commercial available softwares, including also financial systems. For example, production requirements for new and existing garments are distributed to factories without using any smart supply chain optimization software, on the contrary in production relatively simple applications are applied, which presents to factory managers quantities and due dates for all production requested. Managers then use this information to load their factories and put jobs in sequence. Planning and scheduling is also informal, as is also the process of deciding which stores get garments when demand exceeds supply. The most sophisticated technology is used in computer controlled cloth cutter. These machines optimize the use of fabric for all the patterns. Internally developed program is used

in order management and comparing aggregated orders to available inventory. Yet another in-house developed application keeps track of the theoretical inventory in stores (McAffee, 2004).

Ferdows *et al.* (2004) have listed three principles that have made Zara's success possible:

- *Close the loop of communication.* Zara's supply chain is organized to transfer hard data and anecdotal information quickly. It also set up to track materials and products in real time during the whole supply chain. Information about demand is moved towards upstream in the supply chain effectively.
- *Stick to a rhythm across the entire supply chain.* At Zara rapid timing and synchronicity are important. It invests money for developing supply chain and at the same time can have exceeded capacity in order to match supply to increased demand.
- *Leverage you capital assets to increase supply chain flexibility.* Zara has invested to production and distribution facilities. These parts of supply chain can be considered the most capital intensive. This gives Zara ability to control schedules and capacities. No assets are not bind to excess inventories because lead-time for garments can be short as three weeks.

Main reasons Zara's for success is the capability to respond quickly and efficiently to consumers' demands. In addition, Zara emphasize the ability to respond very quickly to the demands of customers and empowering employees of the company. Production volumes are kept low in the beginning of the season and then reacting quickly to changes in demand during the season. Only 15 to 20% of season's garments are delivered before the season, while the industry average is 45 to 60%. In addition, Zara collects full ticket price on 85% of its retail clothing, while the industry average is between 60 and 70% (Ferdows *et al.* 2004). According to McAfee IT has provided major advantages to Zara in running operations, which can be seen superior performance in the industry. IT can help in process standardization and deployment, in assurance of compliance with new processes, in optimization, in automation, in monitoring, in analysis, in control, and in reporting. However, the main focus has been in developing in processes.

5.1.3 Naisten Pukutehdas Oy

Naisten Pukutehdas is family-owned company and it was established 1919. The company's head office in Hollola, Finland. The company's annual turnover reaches 7.0 million euros and the number of employees is around 50. Naisten Pukutehdas has three product lines: NP Collection, NP Casual and NP Pants. In addition product range can be divided into two categories: seasonal collection and continuous collection. 70% of the whole production is exported and the most important target countries are along Scandinavian countries, U.K., Germany, Belgium, Nederland and Russia. The company uses mainly international subcontracting (80%) as well as international suppliers (80%).

Production starts with designing the collection. Designing processes has been under development in Naisten Pukutehdas during recent years (Riikonen and Valkokari, 2004). Seasonal collection is sold up-front and retailers make orders before the production of the collection has even started. Normally, batch sizes of production are decided according to preliminary orders. However, if some product has been selling well, Naisten Pukutehdas can order from some additional pieces exceeding the up-front orders. Continuous collection is manufactured according to demand. Subcontractors are mainly in Estonia and in China. In Hollola facility the company has still warehouse, distribution center and cloth cutter. Some of products are cut in Hollola and then sent to Estonian subcontractor, but mainly the garments are cut in same facilities were the rest of the production is done.

During last years Naisten Pukutehdas has developed business model for continuous collection (figure 7) in order to be apply replenishment strategy with its biggest retailers. Main part of the continuous collection is produced in China and some in subcontractors in Estonia. Retailers' replenishment alarm limits have been set to garment model, size and color level and order is delivered automatically once per week. Moving from own production to managing growing network of suppliers and subcontractors has been challenging. Thus, the follow-up outsourced production and controlling subcontractors are key factors in order to maintain agreed service level in replenishments. The company has developed measurement system for following delivery accuracy.

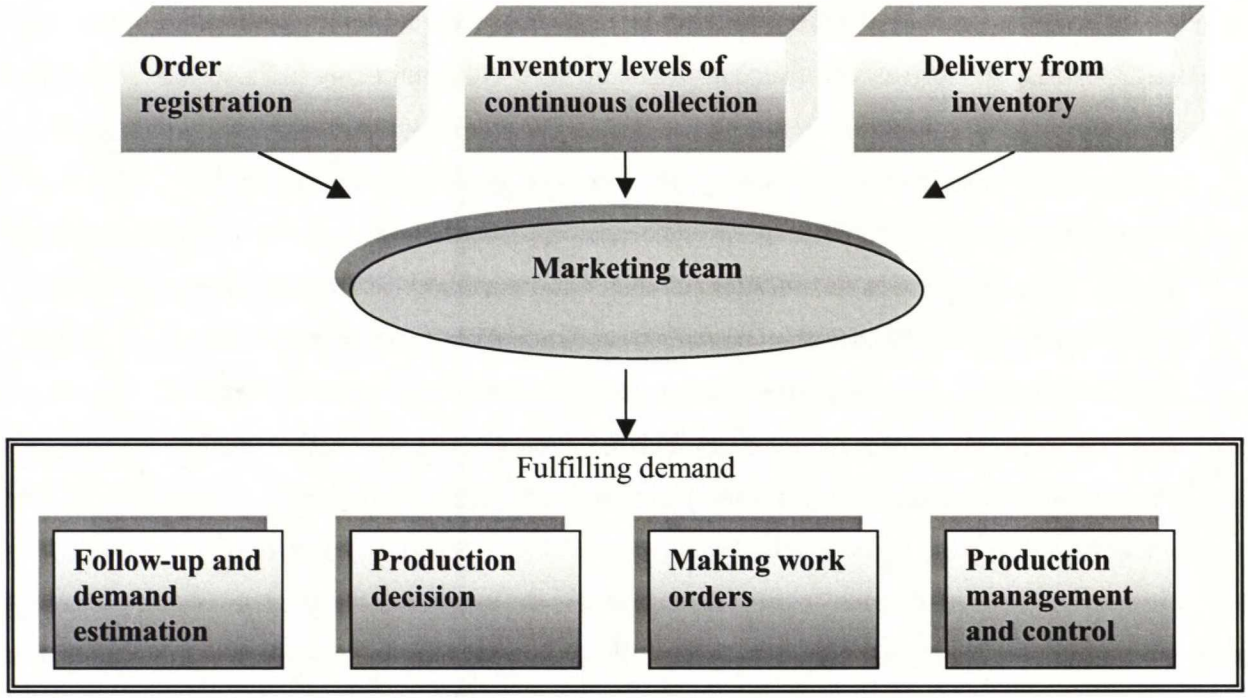


Figure 7. Business model for continuous collection (Heti- myyntimalli) (Riikonen & Valkokari, 2004)

Information system development, especially ERP system, has been seen as competitive advantage in Naisten Pukutehdas. The development of in-house developed ERP system has started already twenty years ago. The ERP system includes financial accounting, material management, production planning and control, order entry and sales, purchasing, financial control, distribution and logistics, asset management, HR management, project management and system administration functionalities. ERP has helped process development and made them more efficient and in addition provided cost savings in operational level. Also the improvements in customer service have been obvious, while company has developed a web portal for making orders, inventory level enquiries, reclamation maintenance and order tracking. This system has been integrated with the company ERP and it helps significantly order maintenance and improve customer service level, because customer can make orders by themselves, track them and also take care of reclamations with the help of this system. Company sales persons can update and synchronize orders from their laptops through Internet to ERP system. At the moment quality management functionalities to ERP are under development.

Even though all the order information for the replenishments as well as for seasonal collection (EDI, XML) is received electronically, the orders to subcontractors are still sent either in paper or by e-mail. Naisten Pukutehdas receives POS information electronically, but product information to retailers' information systems are still input manually, even though EAN codes are the same in the company's ERP and retailers' information system. Retailers can see company inventory levels from Extranet, where they can also place orders and have campaign information. Due to the increased sourcing and subcontracting, Naisten Pukutehdas has used quite a lot of time for custom clearance. Thus, the company has developed automated custom clearing application, which is integrated to company's ERP. This helps to manage international trade and decreases significantly manually made work phases.

Integration level in Naisten Pukutehdas is still mainly internal, and the focus in coordination is still in customer relationships. In Naisten Pukutehdas ERP system is seen as important part of making business processes more efficient. Increased information sharing and ability of share POS data are seen as big improvements, which are expected to increase in the future. Also different possibilities to information system integration are seen as part of the future development. However, general attitudes about information sharing in the industry can hurt the development. Due to the successful development and implementation of ERP system, a separate company, called RDN Networks, was established in year 2005 to market and sell this solution also to other companies in the industry. At the moment RDN Networks and Naisten Pukutehdas are developing together systems for sales forecasting and supply chain planning and optimization (APS) in order to improve SCM in the future.

5.1.4 Everdeal Oy

Everdeal Oy is best known for its brands: Your Face, PetriFun and Mascara. Your Face is concentrating on women's business clothing; Mascara product line includes women jackets and PetriFun in focused on men's clothing. Company is importing their products also to Denmark, Estonia, Latvia Norway, and Sweden. The total amount of export is nowadays 8% from sales. In this pilot case study the focus will be in Your Face collection. You Face - collection include two separate lines: seasonal collection and continuous, Modern Basics collection. Seasonal collection is more trendy collection, and it's complemented during the season with new products. The business concepts for both seasonal collection and continuous collection can be described responsive.

Manufacturing is outsourced and the company has been concentrated to build up their concept and brand by developing logistics competence and responsiveness to customer demand. Everdeal Oy has a subsidiary in Estonia, Everdeal Eesti AS, which is responsible of 60% of the subcontracting. This subcontracting is mainly done with contract manufacturers in the Tallinn –area. In addition Everdeal has Turkish and Chinese subcontractors, which represent a third from subcontracting. 98% of the company subcontractors are international, while every supplier is nowadays international. At the moment, Everdeal is seeking actively new subcontractors in manufacturing, because their business model would require shorter lead-times. The other option has been to establish joint venture. The main idea in this concept has been manufacture garments in a factory that can adjust their production quickly to changes in demand. In practice this would mean cell production, where would be different teams for blazer, trouser and shirt manufacturing. Main material sourcing countries are Spain, Italy and France. Everdeal has a logistic center in Iisalmi, but some of the products are delivered straight to retailers from subcontractor. The logistics service company, called Logia Moda, handles those deliveries. Products are delivered to the retailers with price tags and EAN code stickers. In some cases also international logistics companies are used, for example UPS.

In year 1995 Everdeal Oy started to build their continuous replenishment model for Your Face, called N.O.S. (Never Out of Store). Demand information is delivered once per week to Everdeal and sold products are then replenished according to sales. With the biggest retailers Everdeal has an EDI- connection, and thus the POS information is applied directly in production and order management. Smaller retailers collect EAN code stickers from sold products to the specific report, which is then delivered by fax to the Everdeal and the information is input to the ERP system manually.

In addition with this replenishment model, Everdeal has developed cooperation with some of its biggest retailers, by using shop-in-shop concept. Everdeal sets a certain budget, which is based on amount of square meters and defines up-front and replenishment buying budgets for a retailer. Realization of the budget is followed carefully and necessary changes can be made in collection as well as replenishments. Even though seasonal products are ordered up-front, they can be replenished during the season. However, there are approximately 20 different products in the store at the same time, which demand is followed carefully. If some product is not selling in a certain store it can be moved to another store where it would most likely sell better. With biggest retailers Everdeal has set availability levels, which are used as an

incentive and performance measurement. The company has established also their own stores in addition with the outlet stores. At the moment own stores represent 30% of the total sales. Currently Everdeal is also planning to expand Your Face store chain with the franchising principle.

Everdeal's ERP system is implemented already in 1994 and it includes financial accounting, material management, order entry and sales, purchasing, financial control, warehousing, HR management, executive information system and system administration. The ERP solution can be described as best of breed, while material management, order entry and sales and warehousing are from Dafo and financial management functionalities are from Sonet system. Product register in also in Dafo, but designing is done with special applications. Server and databases are in Helsinki head-office. At time of implementation there were no other suitable applications available, which was the main reason for choosing Dafo. Everdeal sees that their ERP system has provided advantages in many areas, including business process management, productivity, transaction processing and financial management. The ERP system is considered easy to use, and possibilities to further development are considered important but unfortunately quite limited.

Information flow inside supply chain is still handled many ways. Purchase orders and some of the customer orders are done by using e-mail. With the biggest retailers, Everdeal has EDI connection and electronic invoicing. For those customers who don't have ability to receive electronic invoices, they are sent in paper. Purchase invoices are mainly received still in paper as well as some of the bills of freight. Thus, the most common way of data transfer is still done manually. Despite of the EDI connection with biggest retailers, new product information, including EAN codes, can't be transferred directly to the retailers' information system and thus this is also done manually. With own store POS terminals are connected and integrated to company's ERP, where they can see inventory levels and make orders. This POS terminal system has been tailor made to Everdeal.

Everdeal's integration level is considered internal, while they are applying ERP in key business processes. However, the company is focusing in coordination to developing both supplier- and customer relationships. According to company, some retailers have been able to improve their sales up to 80% with the help of process development, especially product replenishments, done during the years. The most important issue in developing business

processes is relating still with people, and not with the system, while the industry is still quite old-fashioned and information sharing is not seen as standard procedure. However, in Everdeal shorter circle times are seen as a result of continuous improvement of business processes, and not so much as a result of ERP system or other information systems. Information systems are seen as one part in business process developing and they offer tools for information sharing.

5.2 Evaluation Framework

One objective of this study was to create an evaluation framework by using previous studies concerning ERP systems, SCM and integration and pilot case studies. Purpose of this section is to describe the framework in order to help to understand its origin. With the help of this framework the aim is then to evaluate ERP system, SCM structure and integration in the textile and clothing industry by the means of case study.

The evaluation framework is built up from four parts: Information Systems, Global Supply Chain, Business Processes and Integration (figure 8). The framework combines ERP structure, global supply chain strategy and practices, key business processes in the industry and integration forms, levels and stages. Thus, the integration will be reviewed in the key business processes in the supply chain. ERP system's role in the whole integration is therefore evaluated with the help of integration of business processes and information, integration level, and integration stage.

The Information System -part is built by combining results from different studies. Firstly, IT system architecture has been described according to Hodge (2000, 2002). In addition with ERP system important information systems in the textile and clothing industry are Product Data Management system (PDM), Manufacturing Execution System, SCM system and CRM system. Description of ERP system structure is based on Davenport (2000), Chiplunkar *et al.* (2001) and Sumner (2005).

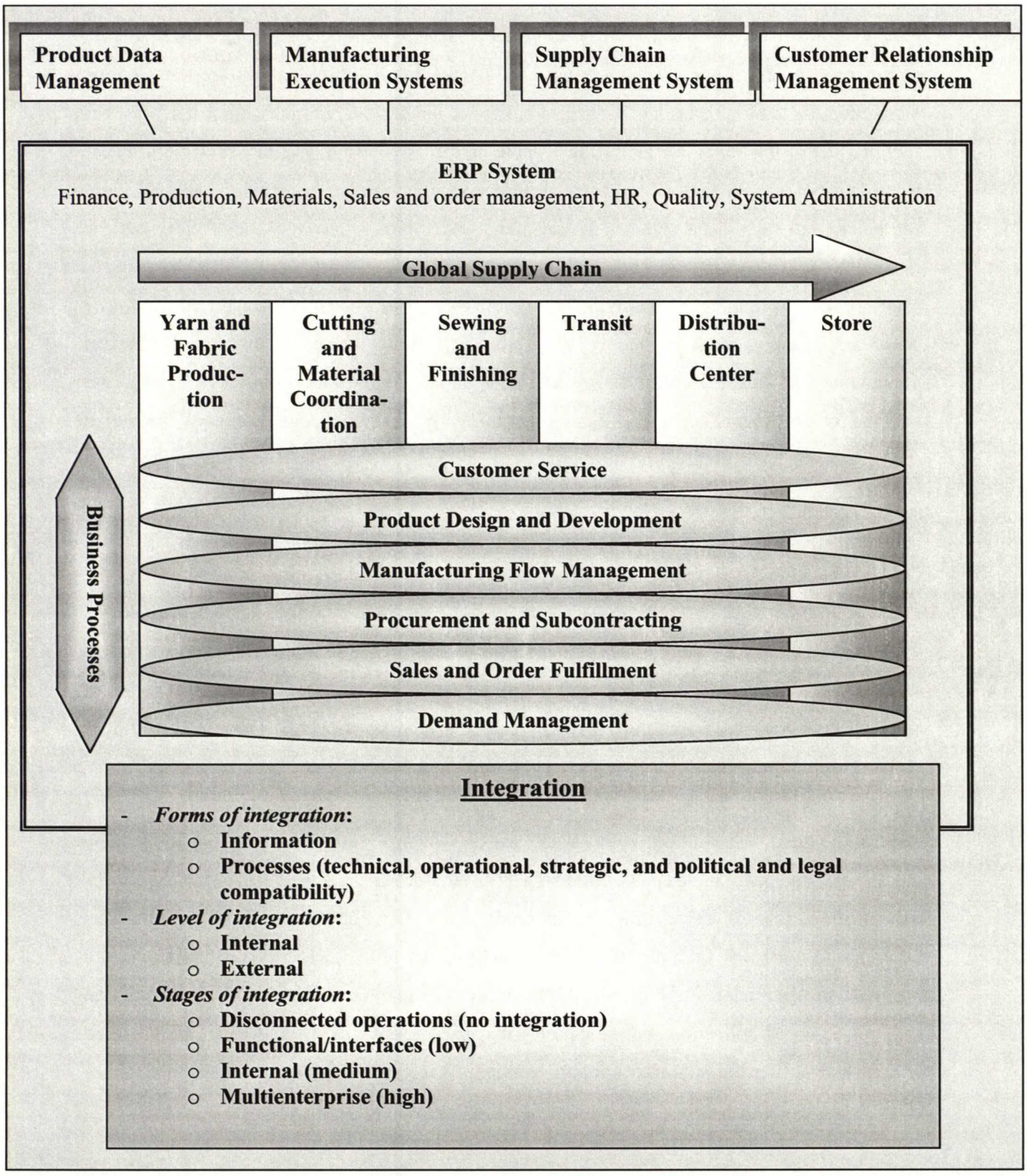
Global Supply Chain structure is described according to Abend (1998) and Mattila (1999). The essential parts of the supply chain are yarn and fabric production, cutting and material coordination, sewing and finishing, transit, distribution center, and retailing. In this study

SCM is reviewed through business processes, which were first listed based on studies by Cooper *et al.* (1997) and Mentzer *et al.* (1999). With the help of pilot case studies the most essential processes in the textile and clothing industry were recognized. The selected six business processes were Customer Service, Product Design and Development, Manufacturing Flow Management, Procurement and Subcontracting, Sales and Order Fulfillment and Demand Management.

Finally, supply chain integration in this study is divided into *forms of integration*, *level of integration* and *stages of integration*. This classification has been incorporated from a different ways of categorize and analyze supply chain integration. Forms of integration were incorporated from two different classifications (Bechtel and Jayaram 1997 and Lee 2000). According to Bechtel and Jayraman (1997) supply chain integration can be divided into four categories: integration of operations, logistics operations and interfaces, information and business processes. Lee (2000) divided integration to three forms: integration of information and coordination and resource sharing and organizational linkage. Both of these approaches include information integration. However, logistics operations and interfaces, operations, coordination and resource sharing and organizational linkages can be defined also as process integration. The level of integration has been divided into two categories according to Romano (2003): internal and external. Division of stages of integration combines three different views (Stevens 1989, Bagchi and Skjoett- Larssen 2003, SAP's Stages of Excellence). The four stages of integration are (1) Disconnected operations (no integration), (2) Functional interfaces (low), (3) Internal (medium), and (4) Multienterprise (high). Stevens (1989) approaches the development of integration through four stages like in SAP's Stages of Excellence, while Bagchi and Skjoett- Larssen (2003) have divided information integration to three stages. Stevens view emphasises processes, while Bagchi and Skjoett-Larssen and SAP have focused to the appliance of technology in their divisions.

Those integration classifications that were based on application or information system integration (Tarn *et al.*2002; Huang *et al.* 2003) were excluded from the evaluation framework, while IT systems and their integration are included partly in the Information System part, and in Business Process and Supply Chain Integration analysis.

Figure 8. Theoretical framework of the study



5.3 Case MASI Company Oy

MASI Company Oy (later Masi) was established 1972 and it produces, manufactures, sources and markets outdoor- and youth clothing. The company's main trademarks are Lee Cooper, Very Nice, Sail&Ski, Tiklas and Fredrikson. Half of the turnover comes from jeans. Masi has two production facilities in Finland: in Keitele and in Säynätsalo. Keitele factory produces jeans and Säynätsalo facility produces different kind of headgears, mainly hats and caps. Marketing and sales department is in Helsinki. The company has also four factory outlets. Annual turnover of Masi is 15.5 million Euros and it has approximately 150 employees (2004). Masi's products can be divided into three categories: *seasonal products*, *continuously produced products* and *private label products*. Supply chain management between continuous and seasonal collection differs quite a lot. Private label products can be either seasonal or continuous depending on contract made with customer. Private label production represents 25% from the total production.

Continuous collection, which is mainly jeans, is sold and produced from 18 months up to 30 months depending on its success. During that selling season design and colouring stays the same. Delivery time with these garments is short and Masi maintains inventory levels corresponding approximately three months sales. In the ERP system there are approximately 1800 different product codes for these continuous collection garments, because of different size and colour codes. Follow up of the inventory level is automated. When alarm limit is reached, production fulfills the inventory up to upper limit.

Seasonal collection is sold only during one season, which normally means six months. The most important issue in seasonal collection is to achieve the planned lead time, while the delivery schedule of these products is predetermined. Retailers order these products beforehand, normally four months prior to selling season. These seasonal products are normally subcontracted and outsourced. Traditionally, up-front sales are 80% from the total sales of seasonal collection, but sometimes it can be even 100%. The rest, 20%, is then replenished during the season according to sales. Replenishments are normally done from Masi's own inventory; during the season this collection is hardly ever produced more.

Even though the company doesn't export, Masi's supply chain can be considered global. Today subcontracting is a big part of the total production, while 70% of sales are subcontracted. In addition, all the subcontractors are international and approximately 90% of suppliers are international. One of the biggest subcontractors is Estonian company, where Masi is renting the facilities and provides all the production machines and know-how to the Estonian company without any ownership.

Masi's vision is to be service company that provides and develops clothing brands, and who applies effectively logistics and information systems in its operations. Key areas of developing its competitiveness are demand driven supply chain and electronic data transmission and control (figure 9). The company has chosen its key success factors fast and flexible deliveries and cost effectiveness. Masi sees that effective SCM including both end of supply chain is the most important competitive advantage, which also guarantees the possibility to produce and deliver small batches according to customer demands. Recent years Masi has invested a lot to improve SCM. Thus, information systems have been seen a big part of this development. The company's strategic goal is to move towards more demand-driven orientation.

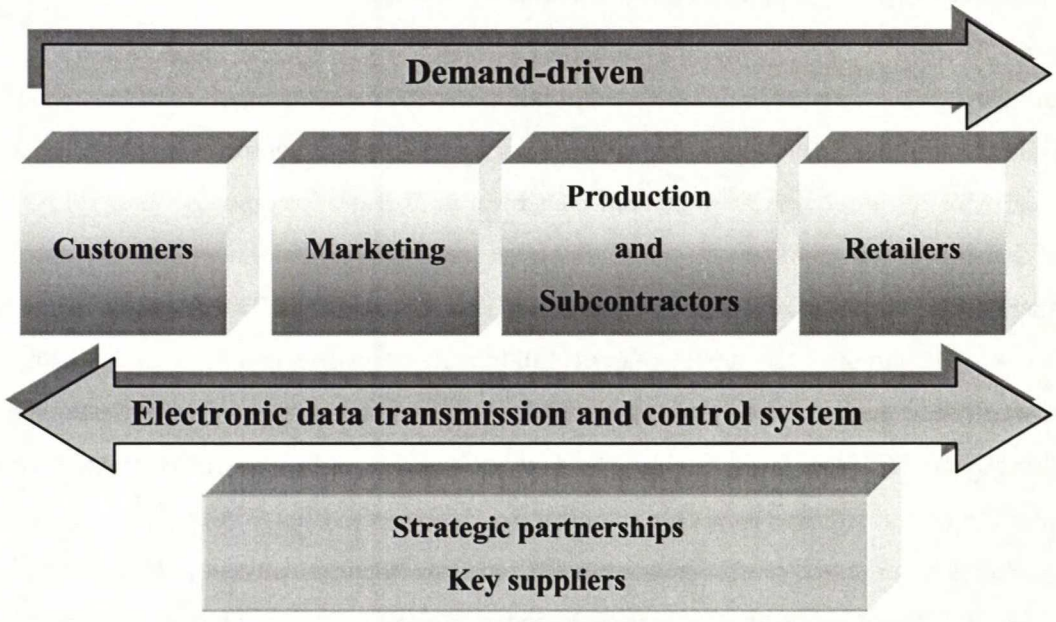


Figure 9. Development model of MASI Company Oy (Riikonen and Valkokari, 2004)

5.3.1 Enterprise Resource Planning

Masi has implemented an industry specific ERP system, Dafo, already in year 2000. The ERP system was implemented, because old system from Siemens Nixdorf was running out of development and support. The old system was implemented 1978, and it can be considered as Manufacturing Resource Planning (MRP II) system. By implementing Dafo Masi was looking forward to achieve cost savings, improving operational efficiency and improving SCM. Also electronic ordering services and integration with key retailers and suppliers were drivers in system renewal.

During the implementation ERP system was tailored, because new system didn't include at that time important features for the production. Thus, there are quite a lot of similarities between the new and old system. The implementation was considered quite easy and painless, mainly for two reasons: the implementation didn't include Business Process Re-engineering (BPR) and new ERP system reminded quite a lot the old legacy system. Software vendor didn't even offer BPR services, but during the implementation industry's best practises were introduced. While the employees were aware of the necessity of this implementation, no big change resistance occurred (Mäkipää, 2002).

Masi's ERP system includes financial accounting, material management, production planning and control, order entry and sales, purchasing, financial control, warehousing, asset management, product management and system administration modules. The ERP can be considered also best of breed, while financial management modules are separate from Tietoenator and Sonet and the other modules are included in Dafo. The servers and databases are in Keitele factory. In Keitele facility all the modules are in use, while personnel in Helsinki office use mainly order entry and sales, purchasing and product management modules. Säynätsalo facility has also the connection to the company's ERP and they use only production functionalities, including material management, production planning and control. Estonian subcontractor has a limited terminal server connection to Dafo. Masi's ERP main user has been building up internal interfaces between ERP and other IT systems. He has also helped to build up EDI connection with biggest retailers. The main objective in this internal integration has been internal information sharing, which is important already for that reason that marketing and some of the designing is in Helsinki and rest of the designing as well as production facilities are in Keitele. For CRM Masi has implemented FrontOffice solution.

5.3.2 Supply Chain Management

Lainema (2002) argues that effective supply chain is the most important competitive advantage that the Finnish textile and clothing industry can achieve. Thus, during time interfaces between manufacturers and retailers will be integrated and manufacturer can use information about customer demand and preferences in SCM. In SCM Masi applies two kinds of strategies depending on collection type. Thus, supply chain strategy differs between continuous and seasonal collection. In continuous collection Masi applies Efficient Consumer Response (ECR) system with its biggest retailers, which are mainly big department stores. Products are delivered according to received POS data once per week based on actual sales. These retailers have also included delivery accuracy targets to their contracts with Masi. In the SCM strategy of seasonal collection both traditional up-front buying and VMI strategy are applied.

The most important part of SCM in Masi is managing its own production and subcontracting. In own production batches are divided into workorders, which are maintained in ERP. Information from sales and inventory control modules steers also production planning. The most essential part of Masi's ERP system in manufacturing management. According to production management study done in the company during year 2005 (Koponen, 2005), the company ERP system is not supporting manufacturing management enough, while some of the short term production planning is still done manually. This means that production optimization is still depending mainly on production planner's skills and know-how. In Dafo the current workload can be followed. Inventory alarm system is built in ERP system, while system controls all the time how much products are sold and how much is coming in production process. In own production lead time is two weeks and amount of in-house production has been lately 280 000 pairs of trousers. In-house production planning is done in six weeks periods and production-scheduling application in ERP is counting if there is coming more into the inventory during those six weeks. Forecasting demand of continuous collection is minimized, because manufacturing of these products is based on replenishing actual sales. With seasonal collection forecasting is based on previous year's sales, but forecasting error is minimized also by starting the production after most of up-front orders are received.

The production in Masi can be divided into six phases: design and pattern making, cutting and material coordination, sewing, laundry, finishing and warehousing (Figure 10). The whole production starts from design and pattern making. Before the serial production starts a few test garments are made in order to see how material fits to production and how much it's shrinks in the laundry process. Changes in pattern can be made then according to material behaviour and shrinkage level.

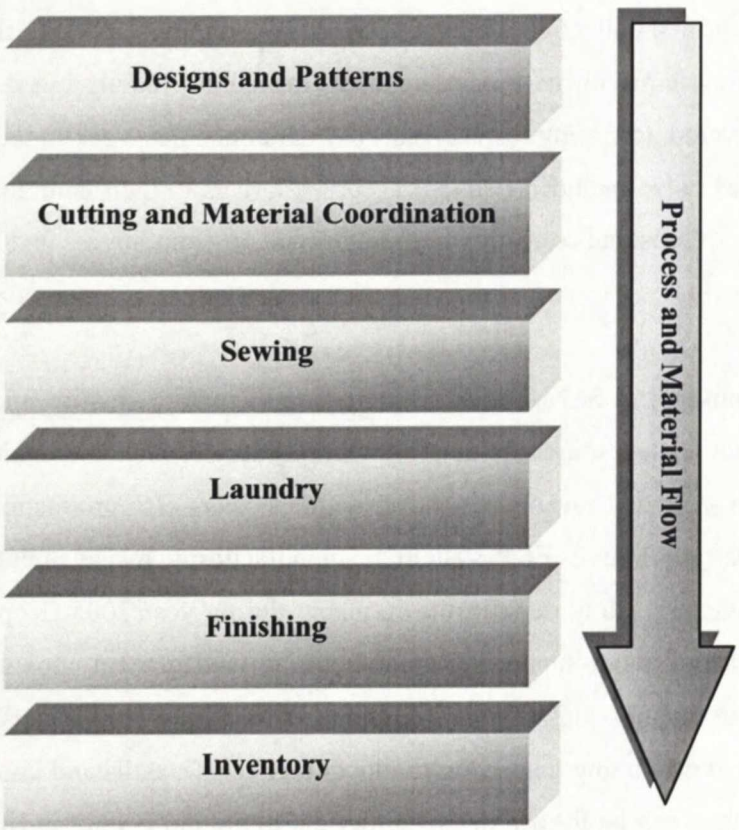


Figure 10. Masi's production flow (modified from Riikonen and Valkokari, 2004)

Purchasing of fabrics for the continuous collection is coordinated and mainly procured from few suppliers. Raw material inventory is controlled and coordinated according to alarm limits. The denim fabrics are purchased from big international suppliers, mainly from Brazil at the moment. Order batches differ time to time and their size is optimised in order to cut costs. For the material inventory there are guidelines for material cycle times, and these are followed. In jeans production also buttons, zippers and yarns play important part. This inventory is also fulfilled according to alarm limits.

Raw materials for seasonal products are ordered after 70-80% of the targeted seasonal sale has been achieved according to product manager's calculations, which is also responsible of procurements. If sales exceed expectations additional orders for fabrics can be done during the season. However, due to the long delivery times this is not always possible, because fabric suppliers make normally materials according to orders. In material procurement planning the company's ERP system is applied.

Masi procures almost all its raw material abroad; only 10% suppliers are Finnish. With continuous collection and seasonal collection material procurement differs from each other. Relationship with key supplier is essential with continuous collection, while fabrics and other raw material for the seasonal collection are procured according to trend forecasts, delivery times and prices. There are approximately 10 permanent fabric suppliers. Fabrics are procured by using agents and the main sourcing countries are Brazil, Germany, Italy and Germany. However, during last years Masi has also emphasized supplier relationship also with seasonal collection purchases in order to improve cooperation with selected suppliers. Other parts, mainly zippers, buttons and rivets are purchased from Finnish supplier and there are altogether 450 different kind of parts. Supplier delivery accuracy and service level has been followed actively, but this follow-up system is not updating supplier information automatically to the company ERP system. According to Masi, the biggest problem with supplier follow-up is scattered responsibilities in purchasing, inaccurate supplier follow-up, lack of automation in routine tasks, large amount of accessories and lack of information sharing about the suppliers.

Cutting and material coordination is based on work orders. This phase is highly automated, while the designs are made with special application and patterns are done then according to these designs. In fabric cutting special application is used in order to minimize the use of fabrics and these cutting plans are moved directly to automated cutter. Small parts, like pockets are moved into own production phase and the bigger parts are transferred into intermediate storage for waiting the smaller parts to be finished.

After cutting and small part production all the parts are moved to sewing. There are four production lines in sewing and production is mainly divided between lines depending on trousers' model, while the machinery is a little bit different between production lines. Approximately fifth of the products are finished with separate a brush robot and all the

trousers are laundered. Finally products are dried and moved into intermediate storage for waiting the finishing.

Workload in sewing can be followed in Dafo, which shows how much there is available and reserved capacity in every stage. Even though workload in production can be followed in ERP, sale information from agents is updated only when they are connected to company's ERP system. This means that production or sales can't trace situation development real time. Production planning in Dafo is done according to sales and inventory levels. According to sales workorders are maintained in Dafo and together with the production planning, product information and workorders, purchase planning is done in Dafo. Information between sales, inventory levels, workorders, and production plans are shared in Dafo.

Subcontracting is based on long-term relationship. Cooperation with subcontractors, which are mainly from Baltic countries, is coordinated quite well. Subcontracted products are mainly seasonal products with a lot of manual work phases. However, some of the seasonal products, mainly jeans, are manufactured in Keitele factory. Normally, Masi designs subcontracted products and defines material specification. Thus, the main responsibility is in Masi and subcontractor purchases materials and manufactures the products according to given specifications. However, some subcontracted products are sourced with full-prize principle, which means that subcontractor purchases the fabrics and other raw materials, produce products and then delivers them by using logistic service provider either straight to the retailer or to the Keitele inventory.

The company's central warehouse is in Keitele, while Masi's own warehouse is used also as a distribution center. Continuous collection is replenished from this warehouse to the retailer's according to demand. Masi has agreed transit with Suomen Posti in order to deliver these replenishment products during the next day. With seasonal products Masi uses third party logistics (3PL) service company. Agreement with 3PL makes sure that all the subcontracted products are transported from subcontractor to the logistics service company's inventory, straight to the retailer or to Masi's warehouse, where these products are then dispatched forward. Information sharing between Masi and 3PL is still done manually by using paper and sometimes e-mail.

Quick replenishments can be offered for every retailer, because orders can be placed also in web portal, called Myyntinet, in Masi's home page. This web portal offers information about available inventory levels and detailed product information. With biggest retailers Masi has agreed continuous replenishments with certain size and colour levels. From biggest retailers POS information about demand is received daily or once per week and products according to sales are then replenished during agreed time frame, which can be even the next day. Information is received in EAN code level which response the codes in Dafo. This information can be converted automatically to Dafo and order is done that way. In the beginning of every season Masi has agreed with some retailers that they can input automatically EAN product codes via Internet straight to retailer's information systems. That way manual work phases can be decreased.

5.3.3 Integration

In this study integration is approached from three different aspects: forms of integration, level of integration and stages of integration (figure 8). Information sharing in the supply chain is mainly done with the help of EDI, paper and e-mail. Purchase orders are mainly sent by e-mail, but big part of the purchase invoices are received still traditionally in paper. Sales orders are received electronically either from company sales agents, or by EDI or from the Myyntinet. Sales invoices are delivered in electronic format and Masi uses a separate operator in invoice handling. At the moment MASI shares demand forecast and inventory level information with some of its suppliers. With retailers some demand forecasts, new product information and POS information are shared, but mainly no other information is shared inside the supply chain, meaning capacity availability, production plans, lead times, order status information. Supply chain coordination has concentrated inside the company and the focus is to inter-functional harmonization within the firm.

Information inside Masi is shared quite effectively, while the organization can be considered lean. The company's integration level is considered internal: at the company level business processes as well as information flows have been integrated with the help of ERP system. However, separate databases in Dafo and in financial management applications limit internal information sharing in some level. ERP has provided also external integration in some key business process, like sales and order management, demand fulfilment and customer service.

Thus, ERP system can be seen as a backbone for integration and enabler this integration. This provides good starting point for further development.

Forms of integration can be divided into information and processes. Integration between Masi and biggest retailers includes both information and processes. While the most of information sharing in the supply chain is focused between Masi and retailers, there is hardly any integration between Masi and its suppliers. At the moment Masi is developing cooperation between its biggest suppliers. Thus, the integration between biggest retailers and MASI has been increasing because of increased supplier coordination.

If SCM and integration is examined through key business processes, customer service, product design and development, manufacturing flow management, procurement and subcontracting, sales and order fulfillment and demand management even accurate picture can be drawn from the status of integration. In customer service process information integration is limited between Masi and its retailers as well as process integration. Customer service process applies CRM application called FrontOffice and Dafo. Also information about invoicing from sales ledger information can sometimes be needed. This means that information is fragmented to different places. Customer care plans and marketing are done in CRM, but there is no connection between the ERP and CRM systems at the moment. While, customer service processes are so strongly related with demand management, visibility inside organization should be increased in order to improve communication between sales and production. Koponen (2005) argues that at the moment lead-time is considerable long, which is caused by the lack of visibility to the production. For some marketing and product information sharing Masi uses their Internet pages, like collection promoting and providing additional information about their collections and brands.

Integration in product design and development is hardly internal from both aspects process and information. The whole process starts from the available fabrics and designer's ideas. In some level demand information for previous season is used in designing new products. During the designing process prototypes are manufactured. Information about used materials is then used in pattern making and in some cases measuring of the garment can be changed if necessary. Because only a few people takes part of this process, in information sharing no IT applications are used. However, the process from designer's desk to finally production takes quite a lot of time.

Processes and information in manufacturing flow management is integrated internally with the help of Dafo. Integration is handled with the help of shared product information, workorders maintaining, and production planning. Procurement and subcontracting are important part of Masi's business processes. However, both information and process integration in these are still limited. Purchasing plans are made according to production plans and subcontracting is decided already when products are designed. These decisions are not based on capacity availability, but rather to long-term relationship with subcontractors. While own production is concentrated to producing continuous collection, and demand information can be applied here in production and procurement planning, and thus integration is easier to achieve both in information and processes.

Retailers can place their orders by using different ordering channels: e.g. using web portal or EDI or by calling to sales personnel. Thus, sales and order fulfilment is using electronic channels efficiently. Order information is updated to Dafo automatically and order status information is followed in the system. In this process both information and process are externally integrated, but only between Masi and its retailers. However, order status information is not available to retailers. The company ERP system has provided possibilities to handle different order channels for retailers both in processes and information, but it could provide same kind of benefits also integration between suppliers, while IT capabilities are improving all the time.

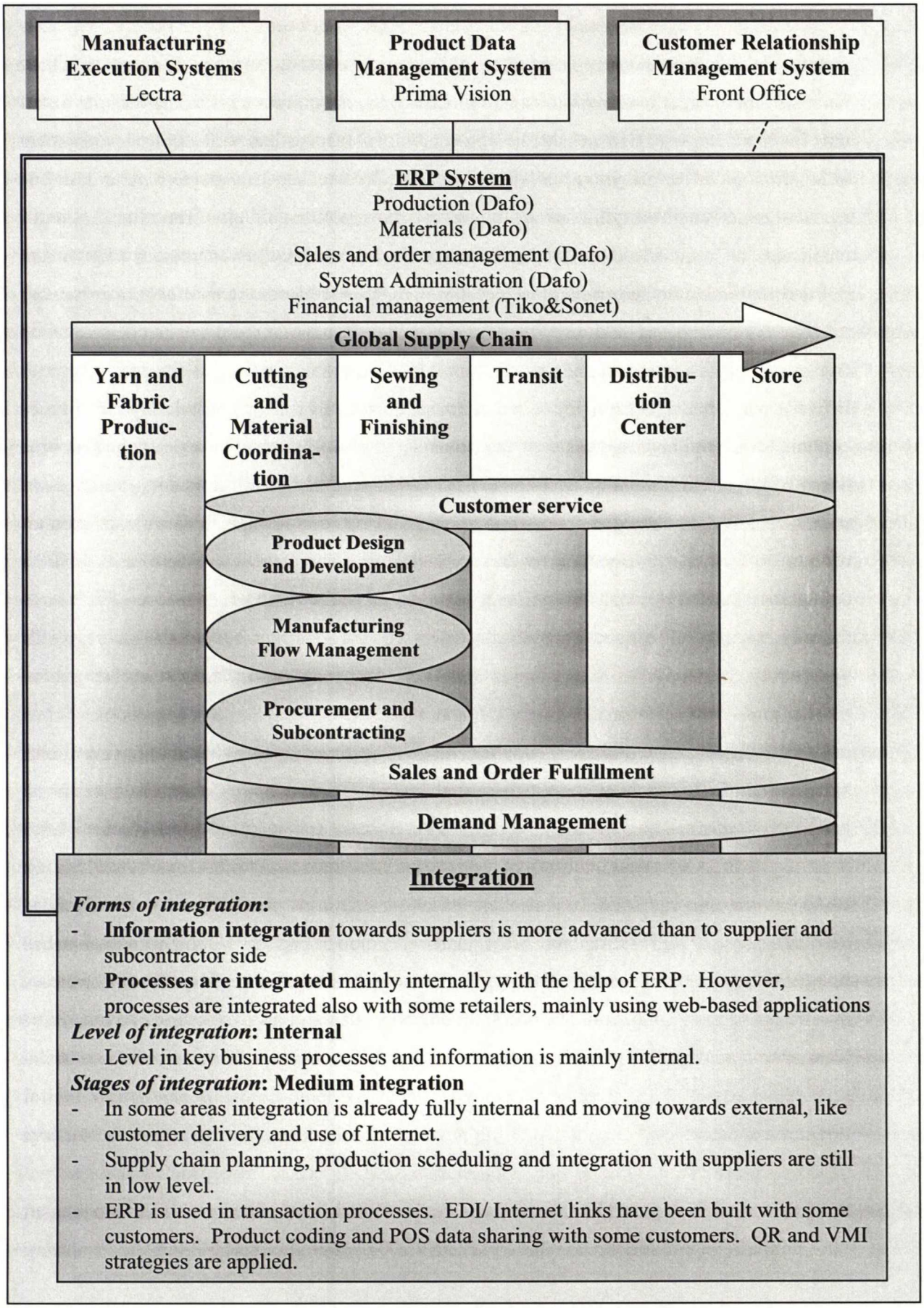
Demand information is shared in some level also in the whole supply chain, and thus demand management information integration with retailers can be considered more advanced than with suppliers. This integration could be developed also towards process integration, while the demand information is nowadays applied quite well in Masi. Thus, the information integration could be expanded to also process integration. The main problem in demand management is that POS data is received only from part of retailers. If this information would be available on larger scale, Masi could do similar demand modelling like VF Corporation by using business intelligence and analytics and thus minimize forecast errors, decrease inventory levels and improve lead-time.

Stages of integration can be evaluated according to capabilities enterprise possesses in different areas, like use of Internet, supply chain planning, production scheduling, integration

with suppliers and customer delivery. Masi applies Internet mainly for two reasons: as a catalogue to share product information and as an order channel. In supply chain planning focus is in informal demand planning and generally integration is focused to functional information in order to decrease inventory and improve efficiency. Production scheduling is applying basic MRP and customer deliveries are made from local inventory. Integration with suppliers is still in FAX/phone and e-mail level. The stage of integration can be considered low (figure 11).

However, the development is moving towards medium level of integration, where both supplier and customer side are integrated and measuring supply chain performance is done actively. This can be proven by the following facts: ERP is used in transaction processes and the aim will be in mechanization of existing processes, EDI/ Internet links have been built with some customers, product coding is uniform with retailers and POS data sharing with some customers, and QR and VMI strategies are applied in SCM. Masi has actively developed their key business processes and they have stated publicly that SCM is strategically important focus area.

Figure 11. Masi in the framework



5.3.4 Scenarios for the Future Development

Biggest retailers have power in setting conditions to contracts, and at the same time they have been also more eager to develop business processes in cooperation with Masi. Despite of this development, majority of Finnish retailing sectors haven't realize what kind of possibilities integration in all levels would provide. In addition, the textile and clothing industry in Finland is so small that it's out of many software vendors focus. These have set big challenges to in-house development of current IT architecture. Even though ERP vendor offers different kind of services, Masi has chosen to develop their system a lot by themselves.

According to Masi international suppliers don't have enough incentives to develop integration between relative small customers. There are several reasons for this, but mainly the question is about strategic choices while costs are considered more important than customer service. Many of these fabric manufacturers have their production facilities in low cots countries and don't see logistics as a competitive advantage. Good, cooperative material suppliers are difficult to find from Europe that would have also necessary capabilities and willingness to cooperation.

The supply chain of Masi is considered quite complex: some products are manufactured in-house, some products are subcontracted and there are several material suppliers. Thus, building interfaces between every supplier and subcontractor is not possible. However, there are possibilities to increase level of external integration without building fixed interfaces between suppliers, subcontractors and customers. Firstly, different kind of electronic market places have been developed during last years also in the textile and clothing industry. These could provide possibilities to buy also small batches of fabrics. Secondly, establishing long-term relationship with fabric and other material suppliers could be one way to increase integration in the supplier side. Thirdly, implementing web-based ERP application, which is available also from Dafo, could be one solution. Key suppliers and subcontractors could then have access to crucial information.

Internet and web-based applications offer several opportunities sharing information in both ends of supply chain. In addition with sharing sales forecasts, also production plans and design information with suppliers could improve integration in the beginning of supply chain. The supplier integration could start with identifying a high-volume supplier with long-

standing cooperation. Then the company should determine what information will be shared, for example product information, capacity information, production plans and forecasts, work orders and their status information and information about shipments. After implementing web-based supply chain solution it should be integrated with host system, meaning ERP.

Both international pilot cases show that using POS information is important in forecasting, planning and producing. Zara's ability to react quickly to customer demand is based on wholly and partly owned manufacturing facilities and use of flexible, local network of subcontractors. Effectively applied POS information together with agile supply chain makes their strategy worth of benchmarking. Similar implications can be found from VF Corporations way of model customer demand based on POS information. Use of BI and analytics in analysing changes in customer demand and in recognizing regional product preferences are applied in effective SCM.

5.4 Summary

In the preliminary interviews in this study the companies estimated internal integration achieved with the help of ERP more important than external integration. These companies saw their role in the supply chain more as a part of it than a key player or critical resource. The size of the companies and global competition in the textile and clothing industry has forced many companies to develop their processes towards demand driven approach. This strategy has offered competitive advantage also to these interviewed companies. Thus, this study showed that successful companies in the textile and clothing industry are applying information system efficiently to support key business processes.

This study confirmed Hodge's (2002) finding that the textile and clothing industry tend to implement order entry and sales, material management and production planning and control ERP functionalities, and thus these systems provide biggest support to manufacturing, sales and order fulfilment and customer service processes. Both Finnish pilot case companies and Masi recognized that ERP has provided several advantaged in all the key areas, like productivity, communication, information sharing, supply chain management, transaction processing, cycle time and financial management.

All the interviewed companies recognized that continuous collection with replenishment strategies is less risky and thus these collections are the foundation for operational efficiency, while seasonal collections were seen more as supporting company brand and image. However, demand driven strategy is seen as a key to achieve better results both in brand management and in financial management. Information sharing with wider use of POS data and increasing integration, both internally and externally, are going to be future trends in the Finnish textile and clothing sector. However, in developing business processes and improving efficiency suppliers' and retailers' attitudes and available resources were seen more critical than technological development. All the case companies presented in this study believe and have also proven that information systems are can provide competitive advantage.

The textile and clothing industry has been forced either to implement industry specific ERP systems or build one in-house. The main reasons have been the product dimensions and type of production, which is a combination of process and unit production. According to this study industry specific ERP systems provide better support to business processes in the textile and clothing industry. So-called standard time systems and use of workorders in production were considered necessities in production control and planning and those were also included to ERP system. Also in subcontracting workorders with the product specifications were used in order management and follow-up.

The key issues that limit external integration are own information systems, either in-house developed or industry specific, and complicated product structure. Some retailers don't have capabilities to have EAN- coding in their own ERP systems for every size and colour of different garment. Replenishment routine is can be applied, because POS information between supplier and retailer can't be shared in these cases. The huge amount of product codes have forced textile and clothing companies to implement industry specific ERP systems, which can be considered also a risk in external integration development. Firstly, the systems are developed to one industry and for that reason it's not always possible to build interfaces with external systems. Secondly, the system development doesn't necessarily follow the development of other systems, for example generic ERP systems and SCM systems.

In addition to ERP, CRM was considered also important, while many companies in the industry, including interviewed companies, have implemented CRM solution. Even though

the companies considered SCM important, none of them haven't implemented any SCM solutions. There can be two reasons: current available SCM solutions requires too much resources compared to benefits or industry specific ERP solutions used in interviewed companies support already in some level SCM. VF Corporation's ability to apply different IT applications in demand and supply chain planning and in forecasting enables them to response changing customer demand quickly even though a lot of subcontracting is done offshore. Implementing these applications and supply chain development has enabled VF Corporation to shorten lead times and decreased inventories. Although ERP has provided shorter lead times in some cases, supply chain flexibility and integration needs also other applications or additional functionalities to existing ERP system, even if manufacturing is subcontracted and less manufacturing is done in-house. Along with increasing subcontracting, the role of ERP applications is moving toward order and demand management from production management.

In internal integration there are still three main problems from information system perspective: managing financial processes, manual data processing and general attitudes. Surprisingly, financial process integration was not considered important neither from the Finnish textile and clothing industry, nor from ERP vendor. At the moment a lot of time is spent in invoice handling and manual financial data processing. Improving and integrating these processes cycle time for money could be decreased. Secondly, while so much information and communication is relying still on faxes, telephone calls and e-mails, this data can't be capture. This lack of historical information limits organizations to develop their current processes. If all the information during key processes is capture, it can be applied in different ways. While the internal integration is perquisite to external integration, these two problems can limit the development. According to interviewed companies attitudes towards information sharing and integration are limiting the development. Key issues that should be considered in successful SCM are e.g. integrated behavior, mutually sharing risks and rewards, collaborative planning and mutual target setting (Mentzer *et al.* 1999). The experiences from mutually agreed service levels in interviewed companies have been positive and it has improved performance in these companies as well as in retailing.

According to Fisher (1997) all activities that aim to synchronize supply with demand, can be considered coordination. Possibilities to coordinate supply chain activities seemed to depend how much power company has on the SCM. Zara's possibility to coordinate its supply chain is based on wholly or partly owned facilities during the manufacturing, delivery and retailing

processes. VF Corporation based its coordination to effective use of information systems, while the company is enormous the processes that enables the supply chain coordination is a key element. The Finnish companies however where concentrated in supply chain coordination to harmonize internal processes in the company. By using Akkermans *et al.* (2003) division about coordination, these interviewed companies have focused their SCM coordination in information deployment and in increasing operational flexibility.

According to these case studies SCM integration and coordination are important issues in strategic management nowadays. Information systems play important role in managing business processes. The Finnish textile and clothing industry have searched new ways of improve their competitive advantages in developing their ability to serve customers. Information sharing and integration within the supply chain are important factors in this and according to this study, these will be increasing in the future.

6 Discussion and Conclusions

Supply chains in the global business environment have become more complex and thus need for information has become greater than ever. The companies are trying to anticipate the harder competition by increasing their efficiency and developing their business processes. Therefore possibilities that information technology can provide are used widely and applied in every industry. Increasing global competition, changes in markets and end of trade restrains have forced companies in the textile and clothing industry to seek competitive advantage from different sources. Thus, different kinds of supply chain strategies, innovations and increasing operational efficiency have become more important to the European companies in the industry.

The main objective of this study was to investigate Enterprise Resource Planning (ERP) softwares in the textile and apparel industry. The aim of this study was *to describe the nature of ERP software, to describe and explain the concept of SCM, to review possibilities ERP provides in integration, to create an evaluation framework for empirical research,* and finally *to review with the help of evaluation framework ERP systems, SCM and integration in the textile and clothing industry.* To carry out the empirical part of this study different kind of material was collected and from these materials case studies was conducted. First, four companies were chosen for interviews, three companies from the textile and clothing industry and one ERP vendor. Also secondary material was collected, including trade magazine articles, journal articles, press releases, company reports and companies' website information. The empirical part was divided into two parts. First four pilot case studies, two Finnish and two international, were executed. Then, evaluation framework was created together with these case studies and theoretical part of this thesis. In the second part a case study the evaluation framework was then applied and ERP system, SCM and integration was reviewed.

6.1 Key Findings of the Study

Companies in the textile and clothing industry tend to implement industry specific ERP systems, while the extensive amount of products set high demands for the system. Also the special features in production and sales seemed to be drivers for choosing industry specific

ERP application. This study confirmed that the textile and clothing company tend to implement more often material management, production management and order entry and sales modules. Companies have been applying their information systems in developing new ways of compete in the global business environment. In addition with ERP system, the companies have been implemented also PDM applications, Manufacturing Execution System and some also CRM systems. It is obvious that size of the textile and clothing companies in Finland limit extensive IT investments.

In the global supply chain ERP system provided integration mainly in Customer Service, in Sales and Order Fulfillment and in Demand Management processes, while in Product Design and Development, in Procurement and Subcontracting and in Manufacturing Flow Management processes the integration has been mainly internal. ERP has provided major advantages in own production management and increased internal integration in the textile and clothing industry. ERP has provided benefits in order management, while different kind of ordering channels are applied in the Finnish textile and clothing industry. EDI connection with biggest suppliers has provided possibility to apply responsive supply chain strategy. Together with information systems these Finnish case companies have been able to build demand based replenishment models, which reminds QR –strategy. In this business model EDI connection creates the integration interface between supplier and retailer and effective ERP systems enables effective order management and fulfillment.

This study confirmed Romano's (2003) assumption that internal integration is a prerequisite for external, inter-company integration. Information technology is nowadays playing a bigger role in forecasting in the Finnish textile and clothing companies and companies are defining more precisely what information is wanted and how it can be applied. However, industry specific ERP systems and extensive amount of product codes might be obstacle in external integration, while the information systems of other supply chain members have limited capabilities. Also attitudes and lack of shared supply chain strategy have been holding back the development in integration.

Subcontractors and suppliers are nowadays mainly international and this sets high demand for SCM and information systems. This study outlined the problems in subcontractor and supplier integration, which has not been developed at the same pace as integration in the end of supply chain. Important issues in the future will be how ERP systems could be integrated

with subcontractors and logistics partners systems. In addition, automatization of raw material procurement will have important role. Sumner (2005) suggests that integrating supply chain requires commitment to strategy, processes, organization and technology, which this study supports. It seems that integration can be achieved by setting common targets, building long-term relationship in the beginning and in the end of supply chain and it requires commitment from all participants.

The evaluation framework developed in this study provided a good basis for analysing role of ERP system in SCM management and supply chain integration. In this study integration was reviewed from three angles: forms of integration, level of integration and stage of integration. These were chosen according to previous studies and some classifications were left out from the framework, e.g. information system oriented approaches of integration. The key business processes were selected according to case studies and the pilot case companies are innovative and competitive companies that have applied information systems, including ERP quite well in their SCM. These two issues can limit the wider use of this framework.

Two important themes came up in this study: information sharing in the supply chain and the role of information systems, especially ERP systems. In order to be competitive in the continuously changing markets, companies in the Finnish textile and clothing industry must be able to be responsive to changing customer demands. This can be done by effective SCM, which relies on wide use of information technology and therefore integration in different forms and levels. The most important change during last ten years has been sharing of sales information in the supply chain. In the future companies expect that more information will be shared, which makes easier to make demand forecasts. Also increased information sharing and use of POS information enables companies to analyse and make models from data. For sure information systems, including ERP systems, will play an important role in this.

6.2 Suggestions for Future Research

This study has revealed several shortcomings in SCM in the textile and clothing industry. Thus many Finnish companies in the industry have limited financial and human resources, companies must be able to developed their operational efficiency and improve their ability to response changing customer demand. During this study many interesting aspects came up.

For example what kind of possibilities applying Internet would provide in more responsive subcontracting and sourcing? How electronic market places could be used in material procurement? How retailers could be part of supply chain and IT system development in the future? What kind of role shared performance measurement and management systems could have in the future? How global process integration could be increased without increasing vertical integration and without too big financial investments? While the information systems don't nowadays limit effective information sharing, the key issue will be how to change general attitudes towards information sharing in the whole supply chain.

The evaluation framework developed in this study could be applied also in other industries for analyzing ERP system, SCM and integration. While the one key issue in the framework is the global supply chain and its processes, these should be modified to fit to the certain industry sector. The evaluation framework could be developed also further for example by adding SCM coordination to the framework. Also including some aspects of analyzing enterprise application integration could increase applicability of this framework.

This study raised the important questions about industry specific information systems. In the future, it would be also interesting to see other similar studies from other industries. What have been the main reasons for the development? What kind of evolution these systems have experienced during last years and what is the focus in developing these systems forward?

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Mr. Juha-Pekka Heikkinen, Director, WM Data. Tampere. 24.2.2006

Appendices

Appendix A: <u>The questionnaire used in the textile and clothing industry interviews</u>

<u>Taustatietoja (Background)</u>

1. **Yrityksen nimi** (Company name):
2. **Haastateltava** (Interviewee):
3. **Tuotelinjat** (Product lines):
4. **Kuinka paljon** (How much your)
    a. **alihankkijoistanne on kansainvälisiä** (subcontractors are international)?
    b. **tavarantoimittajista on kansainvälisiä** (suppliers are international)?
    c. **jälleenmyyjistänne on kansainvälisiä** (retailers are international)?
5. **Mikä on viennin osuus liikevaihdosta?**
   (What is the total amount of export from turnover?)
6. **Mikä on oma asemanne toimitusketjussa? (toimittaja, alihankkija tuotetehdas, jakelija, tukkuri, jälleenmyyjä, palveluyritys)**
   (What is your position in the supply chain?)
7. **Mikä on yrityksenne rooli toimitusketjussa? (määräävä, hallitseva tekijä, orkestroija /koordinaattori, kriittisen resurssin tai palvelun tarjoaja, osa toimitusketjua/ osallinen)**
   (What is your role in supply chain?)
8. **Kuinka paljon tuotteistanne on** (How much of your products are produced under)
    a. **Omalla tuotemerkillä** (Your own brand)?
    b. **Private –label valmistusta** (Private-label/ customized)?
9. **Hyödynnättekö jotain tietojärjestelmää seuraavissa**?
   (Do you apply information system in following?)
    a. Tilausten käsittely (Order handling)
    b. Varaston valvonta (Inventory management and control)
    c. Tuotannon suunnittelu (Production planning and scheduling)
    d. Myynnin ennustejärjestelmät (Sales forecasting system)
    e. Jakelunsuunnittelujärjestelmät (Distribution planning systems)

f. Toimitusketjun suunnittelu- ja optimointijärjestelmät (Supply chain planning and optimization (APS))

Enterprise Resource Plannning (ERP)

1. **Onko yrityksessänne käytössä toiminnanohjausjärjestelmä** (Do you have ERP system)?
    a. Mikä järjestelmä (What system)?
    b. Käyttöönottovuosi (Implementation year)?
    c. Mitkä seuraavista osajärjestelmistä/moduuleista teillä on käytössänne (What modules you have implemented)?
        i. Taloushallinnon (Financial Accounting)
        ii. Materiaalihallinta (Material Management)
        iii. Tuotannonohjaus (Production Planning/Control)
        iv. Tilausten hallinta/myynti (Order Entry/ Sales)
        v. Osto (Purchasing)
        vi. Sisäinen laskenta (Financial Control/ Controlling)
        vii. Jakelu ja varastointi (Distribution, logistics, warehousing)
        viii. Käyttöomaisuuden hallinta (Asset Management)
        ix. Laadun hallinta (Quality Managament)
        x. Henkilöstöhallinto (HR Management)
        xi. Ylläpito (Plant maintenance)
        xii. Tuotehallinta tai T&K (Product management or R&D Management)
        xiii. Projektin hallinta (Project Management)
        xiv. Johdon tietojärjestelmä (Executive Information Systems)
        xv. Järjestelmän hallinta (System Administration)
        xvi. Muut (Other)
2. **Onko yrityksenne vaihtamassa tai laajentamassa toiminnanohjausjärjestelmää**? (Is your company planning to change or expand current ERP system)
3. **Mitkä olivat tärkeimmät tekijät, joiden vuoksi järjestelmä hankittiin?** (What were the most important issues influencing the implementation decision?)
4. **Mitkä olivat järjestelmän tärkeimmät valintakriteerit?** (What were the most important criteria in choosing the system)?
5. **Kuinka tärkeitä seuraavat osa-alueet olivat järjestelmän valinnassa (1= ei lainkaan tärkeä… 5= erittäin tärkeä tai 0- en osaa sanoa)?**

(How important were following in ERP selection?)

a. Toiminnan tehostuminen (Operations effectiveness)
b. Kustannussäästöt (Cost savings)
c. Järjestelmän avulla saavutetut liiketoimintahyödyt (business benefits achieved with the help of ERP)
d. Järjestelmän toimittajan ominaisuudet (ERP vendor's capabilities)
e. Myyntityö (Sales)
f. Toimitusketjun hallinnan tehostuminen (Supply Chain Management)

6. **Kuinka tärkeää toiminnan tehostuminen tai kehittäminen seuraavilla osa-alueille yleensä? (1= ei lainkaan tärkeä... 5= erittäin tärkeä tai 0- en osaa sanoa)?**

(How important are following in generally)

a. Taloushallinto (Financial Management)
b. Materiaalinhallinta (Material Management)
c. Tuotannonohjaus (Production Management)
d. Tilausten hallinta/ Myynti (Order Management/ Sales)
e. Ostotoiminta (Purchasing/ procurement)
f. Toimitusketjun hallinta (Supply Chain Management)

7. **Mitkä seuraavista ovat tärkeitä ERP järjestelmän valinnan ja toimivuuden kannalta (1- ei lainkaan tärkeä... 5- erittäin tärkeä, 0- en osaa sanoa)**?

(How important are following for ERP system selection and functionality?)

a. Järjestelmän hankintahinta (Aquisition price)
b. Integroitavuus yrityksen omiin järjestelmiin (Ability to integrate to internal systems)
c. Integroitavuus ulkopuolisiin järjestelmiin (Ability to integrate to external systems)
d. Muokattavuus/ laajennettavuus (esim. erillinen SCM moduuli) (Ability to expand/modify)
e. Järjestelmän erikoistuminen yrityksenne toimialalle (Industry specificity)
f. Järjestelmän käyttöönoton helppous (Easy to implement)
g. Koulutus- ja tukipalvelut (Support and training)
h. Mahdollisuudet vaikuttaa järjestelmän tuotekehitykseen (Possibilities to influence to system development)
i. Järjestelmän tuotekehityksen jatkuvuus (Continuing system development)
j. Helppokäyttöisyys (Easy to use)

k. Räätälöitävyys (Tailoring possibilities)

l. Muu, mikä (Other, what)

8. **Onko ERP järjestelmä edesauttanut tai tarjonnut selkeitä etuja seuraavilla osa-alueille?**

(Has ERP system helped or provided business benefits in these areas)

a. Kiertoaika (Cycle time)

b. Tiedon käsittely (Transaction processing)

c. Talouden hallinta (Financial management)

d. Liiketoimintaprosessien kehittäminen (Business processes)

e. Tuottavuus (Productivity)

f. Toimitusketjun hallinta (Supply Chain Management)

g. eBusiness

h. Tiedonvälitys (Information sharing)

i. Kommunikointi (Communication)

9. **Kuinka tärkeitä seuraavat seikat ovat olleet järjestelmän valinnassa ja kehityksessä (1- ei lainkaan tärkeä... 5- erittäin tärkeä, 0- en osaa sanoa)?**

(How important following issues have been in ERP system selection and development?)

a. Koventunut kilpailu (Increased competition)

b. Toimittajien sekä alihankkijoiden vaatimukset (Suppliers' and subcontracors' demands)

c. Asiakkaiden/ jälleenmyyjien vaatimukset (Customers' and retailers' demands)

<u>Integraatio ja koordinaatio (Integration and Coordination)</u>

1. **Mitä tietoa jaatte toimittajille tällä hetkellä (1 ei lainkaan... 5: kaikki)?**

(In what extend following data is shared with suppliers)?

c. Kysyntäennusteet (Demand forecast)

d. Kapasiteetin saatavuus (Capasity availability)

e. Tuotantosuunnitelmat (Production plans)

f. Läpimenoajat/ toimitusajat (Lead times)

g. Varastotasot (Inventory levels)

h. Tilausten statustiedot (Order status information)

i. Tuote- ja tuotantokykyinformaatio (New product and production capability info)

j. Myyntitiedot (Sales data/POS- data)

2. **Mitä tietoa jaatte asiakkaille tällä hetkellä (1 ei lainkaan... 5: kaikki)**
   (In what extend following data is shared to customers/retailers)?
   a. Kysyntäennusteet (Demand forecast)
   b. Kapasiteetin saatavuus (Capasity availability)
   c. Tuotantosuunnitelmat (Production plans)
   d. Läpimenoajat/ toimitusajat (Lead times)
   e. Varastotasot (Inventory levels)
   f. Tilausten statustiedot (Order status information)
   g. Tuote- ja tuotantokykyinformaatio (New product and production capability info)
   h. Myyntitiedot (Sales data/POS- data)
3. **Missä muodossa tietoja välitetään toimitusketjun jäsenten kesken (puhelin, faksi, EDI, XML, Internet, extranet, sähköposti, muu)?**
   (In what form following information is transformed between SC members)
   a. Ostotilaukset (Purchase orders)
   b. Asiakastilaukset (Sales orders)
   c. Ostolaskut (Purchase invoices)
   d. Myyntilaskut (Sales invoices)
   e. Kuormakirjat/rahtikirjat (Way-bill/ bills of freight)
   f. Kysyntäennusteet (Demand forecast)
   g. POS –data
   h. Varastotasot (Inventory levels)
   i. Kampanjatiedot (Promotion information)
4. **Mitkä ovat merkittävimmät muutokset informaation jakamisessa sitten 90-luvun puolivälistä tähän päivään** ?
   (What are the most significant changes in information sharing during last decade)
5. **Millaisia tulevaisuuden odotuksia teillä on informaation jakamisen osalta?**
   (What expectations your company have in information sharing in the future)
6. **Kuinka merkittävä tulee olemaan tietojärjestelmien osuus tässä**?
   (What is the role of information systems)
7. **Missä laajuudessa IT järjestelmänne on integroitu?**
   (In what extend your information systems have been integrated)

a. Ei lainkaan (Not at all)
b. Toimintokohtaisesti (esimerkiksi myynti) (Company-wide per function)
c. Toimintojen välinen integraatio yrityksen sisällä (Inter-functional within the company)
d. Yritystasolla toiminnanohjausjärjestelmä (Company level (ERP))
e. Yritysten välillä osa toiminnoista on integroitu (Inter-company: integration of some functions)
f. Yritysten väliset prosessit ja järjestelmät (Inter-company processes and systems)
g. Toimitusverkon prosesseja (Processes extending over the supply network)

8. **Mikä on toimitusketjun koordinointitoimenpiteiden painopiste** (What is the focus of coordination in SC)?
   a. Ei erityisiä koordinointitoimenpiteitä (No special coordination efforts)
   b. Yrityksen sisäisten toimintojen harmonisointi (Inter-functional harmonization within the firm)
   c. Toimittajasuhteet (Supplier relationship)
   d. Asiakassuhteet (Customer relationship)
   e. Sekä asiakas- että toimittajasuhteet (Both supplier and customer relationship)
   f. Moniportainen toimitusketju (Supply chain with multiple tiers)
   g. Verkoston (network, extended supply chain)
9. **Mitkä seikat tai ominaisuudet ovat mielestänne tulevaisuudessa tärkeitä, jotta yrityksen tietojärjestelmät eivät estä toimitusketjun kehittämistä?** (What issues will be important in the future that information systems won't hinder the development of supply chains?)
10. **Voidaanko tietojärjestelmien avulla saavuttaa mielestänne kilpailuetua?** (Can information systems provide competitive advantage)?

Appendix 2: <u>The Questionnaire used in the ERP vendor interview</u>

1. **Järjestelmän nimi?**

   (Name of your ERP system?)

2. **Onko ERP järjestelmä toimialakohtainen vai yleinen?**

   (Is it industry specific or general ERP?)

3. **Mitkä seuraavista toiminnallisuuksista järjestelmästänne löytyy?**

   (What modules are included in your package?)

   a. Taloushallinnon (Financial Accounting)
   b. Materiaalihallinta (Material Management)
   c. Tuotannonohjaus (Production Planning/Control)
   d. Tilausten hallinta/myynti (Order Entry/ Sales)
   e. Osto (Purchasing)
   f. Sisäinen laskenta (Financial Control/ Controlling)
   g. Jakelu ja varastointi (Distribution, logistics, warehousing)
   h. Käyttöomaisuuden hallinta (Asset Management)
   i. Laadun hallinta (Quality Managament)
   j. Henkilöstöhallinto (HR Management)
   k. Ylläpito (Plant maintenance)
   l. Tuotehallinta ja T&K (Product Management and R&D)
   m. Projektin hallinta (Project Management)
   n. Johdon tietojärjestelmä (Executive Information Systems)
   o. Järjestelmän hallinta (System Administration)
   p. Muut (Other)

4. **Onko ERP järjestelmänne integroitavissa yrityksen sisällä seuraaviin sovelluksiin tai järjestelmiin?**

   (Can this ERP system be integrated with following applications?)

   a. Asiakkuuden hallinta (CRM)
   b. Toimitusketjun hallinta (SCM)
   c. Toimitusketjun suunnittelu ja optimointi (APS)
   d. Erillinen tuotehallinta, PDM (Product Data Management)
   e. Raportointi (Business Intelligence)
   f. Tuotannon ohjaus (Manufacturing execution systems)

g. CAD, kaavoitus tai muu vastaava (CAD, pattern making, cutting software)

5. **Voidaanko ERP järjestelmä integroida myös yrityksen ulkopuolisiin järjestelmiin? Miten? Mihin**?
   (Can your ERP be integrated with external applications?)
6. **Mikäli ERP on integroitavissa muihin järjestelmiin, mitä vaihtoehtoja on?**
   (If yes, what are the options?)
   a. Väliohjelmisto (Middleware)
   b. Erityinen integraatio-ohjelmisto (Special Integration Software)
   c. Jokin muu, mikä? (Other, what?)
7. **Kuinka tärkeänä osana toimitusketjun hallinnan näette ERP järjestelmän?** (How important part of supply chain management ERP is?)
8. **Mitkä ovat suurimmat haasteet järjestelmäkehityksessä tällä hetkellä?**
   (What are the biggest challenges in system development at the moment?)